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Arsenic Removal from Drinking Water by Adsorptive Media U.S. EPA Demonstration Project at Hot Springs Mobile Home Park in Willard, Utah Final Performance Evaluation Report

by

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Sally Gutierrez, Director
National Risk Management Research Laboratory

ABSTRACT

This report documents activities performed for and results obtained from the arsenic removal treatment technology demonstration project at the Hot Springs Mobile Home Park (HSMHP) in Willard, UT. The objectives of the project were to evaluate the effectiveness of Adsorbsia™ GTO™ adsorptive media combined with Birm®/Filox™ oxidizing media (as a pretreatment) in removing arsenic to meet the new arsenic maximum contaminant level (MCL) of 10 μg/L. Additionally, this project evaluated (1) the reliability of the treatment system, (2) the required system operation and maintenance (O&M) and operator skill levels, and (3) the capital and O&M cost of the technology. The project also characterized the water in the distribution system and process residuals produced by the treatment process.

The water system at HSMHP was supplied by a supply well (Well No. 2) and a backup well (Well No. 1). Arsenic concentrations in source water from Well No. 2 ranged from 9.4 to 21.1 μg/L and averaged 13.2 μg/L. Of the soluble fraction, As(III) and As(V) each accounted for almost half of the concentrations. Source water also contained, on average, 276 μg/L of total iron and 116 μg/L of total manganese. Therefore, pretreatment was needed to remove iron and manganese and oxidize soluble As(III) to soluble As(V) prior to adsorption by Adsorbsia™ GTO™.

The 30-gal/min (gpm) arsenic treatment system consisted of two integral parts. The oxidation/filtration unit consisted of two 24-in × 72-in vessels, each containing 5 ft^3 of Birm® and 5 ft^3 of Filox™ media; the adsorption unit consisted of one 24-in × 72-in vessel containing 10 ft^3 of Adsorbsia™ GTO™ media (the actual amount was 10.3 ft^3). Birm® is a manganese dioxide-coated media and Filox™ is a manganese dioxide-based media; both are commonly used for iron and manganese removal. Adsorbsia™ GTO™ is a granular titanium oxide media manufactured by the Dow Chemical Company for arsenic removal.

Operation of the treatment system began on December 11, 2008. The types of data collected included system operation, water quality (both across the treatment train and in the distribution system), process residuals, and capital and O&M cost. During the performance evaluation study period from December 11, 2008, through October 18, 2010, the system treated 5,629,000 gal (or 73,010 bed volumes [BV]) of water based on a flow meter/totalizer installed on the adsorption vessel and 10.3 ft^3 (or 77.1 gal) of Adsorbsia™ GTO™ media in the vessel. Daily run times averaged 23.4 hr/day and daily water demands averaged 8,354 gpd. Flowrates to the adsorption vessel varied extensively from 0.7 to 24.0 gpm and averaged 7.3 gpm. Due to the fluctuating flowrates, empty bed contact times (EBCTs) in the adsorption vessel varied extensively from 3.2 to 110 min and averaged 10.6 min. The average EBCT was four times the vendor recommended value of 2.5 min.

Pretreatment with Birm®/Filox™ removed approximately 21% of total arsenic, leaving 10.4 μg/L (on average) in the influent to the adsorption vessel. Total arsenic at this point existed mainly as soluble As(V), indicating effective oxidation of soluble As(III) by Birm®/Filox™. Birm®/Filox™ also was effective in removing iron and manganese, reducing their concentrations to <25 and 4 μg/L (on average), respectively. Daily backwashing appeared to be effective in maintaining Birm®/Filox™ performance; no sign of iron leakage or media fouling was observed during the performance evaluation study.

Adsorbsia™ GTO™ further removed soluble As(V) to below the 10-μg/L arsenic MCL throughout the 22-month study period. By the end of the performance evaluation study, the total arsenic concentration in the system effluent was 6.2 μg/L. At this point, the system had treated approximately 69,200 BV of water, compared to the vendor estimated media life of 168,000 BV.

Each pre-oxidation vessel was backwashed daily at 47 gpm for 8 min, producing 376 gal of wastewater (752 gal for two vessels). The wastewater contained 29.8 mg/L (on average) of total suspended solids (TSS); therefore, 85 g (0.2 lb) of solids were discharged daily. As expected, the solids were comprised mainly iron (8.9 g).

Comparison of the distribution system sampling results before and after system startup showed significant reductions in total arsenic, iron, and manganese concentrations. Total arsenic concentrations decreased from an average of 11.2 to 3.2 µg/L; total iron from 70 µg/L to less than the method detection limit (MDL) of 25 µg/L; total manganese from 19.5 to 8.8 µg/L. Neither lead nor copper concentrations at the consumers' taps appeared to have been impacted by system operation.

The capital investment cost for the system was $66,362, including $46,267 for equipment, $3,850 for site engineering, and $16,245 for installation. Using the system's rated capacity of 30 gpm (43,200 gal/day [gpd]), the normalized capital cost was $2,212/gpm ($1.54/gpd). The O&M cost included the cost for media replacement and disposal, electricity consumption, and labor. Neither the oxidizing nor the adsorptive media required replacement during the study period. The media replacement and disposal cost would represent the majority of the O&M cost and was estimated to be $8,175 for 20 ft^3 of Birm®/Filox™ and $8,440 for 10 ft^3 of Adsorbsia™ GTO™. It was estimated that both Birm®/Filox™ media would have a life expectancy of 10 years.

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ABBREVIATIONS AND ACRONYMS

Δp	differential pressure
AAL	American Analytical Laboratories
Al	aluminum
AM	adsorptive media
As	arsenic
ATS	Aquatic Treatment Systems
bgs	below ground surface
BV	bed volume
Ca	calcium
CA WET	California Waste Extraction Test
Cd	cadmium
C/F	coagulation/filtration
cm^3/g	cubic centimeters per gram
CWS	community water system
DDW	Division of Drinking Water
DO	dissolved oxygen
EBCT	empty bed contact time
EPA	U.S. Environmental Protection Agency
Fe	iron
g/cm^3	grams per cubic centimeter
g/L	grams per liter
gpd	gallons per day
gpm	gallons per minute
H_2SO_4	sulfuric acid
HCl	hydrochloric acid
HIX	hybrid ion exchanger
HNO_3	nitric acid
hp	horsepower
HSMHP	Hot Springs Mobile Home Park
ICP-MS	inductively-coupled plasma/mass spectroscopy
ID	iron addition
IR	iron removal
IX	ion exchange
m^2/g	square meters per gram
MCL	maximum contaminant level
MDL	method detection limit
MEI	Magnesium Elektron, Inc
Mg	magnesium

ABBREVIATIONS AND ACRONYMS (Continued)

mg/L	milligrams per liter
µg/L	micrograms per liter
Mn	manganese
MnO_2	manganese dioxide
Na	sodium
NA	not available
NaOC1	sodium hypochlorite
NaOH	sodium hydroxide
$Na_2S_2O_3$	sodium thiosulfate
NH_3	ammonia
Ni	nickel
NO_3	nitrate
NO_2	nitrite
NRMRL	National Risk Management Research Laboratory
NS	not sampled
NSF	NSF International
NTU	nephelometric turbidity unit
O&M	operation and maintenance
OIT	Oregon Institute of Technology
ORD	Office of Research and Development
ORP	oxidation-reduction potential
P	Phosphorus
Pb	lead
pCi/L	pico Curies per liter
PLC	programmable logic controller
PO_4^{3-}	orthophosphate
POU	point of use
psi	pounds per square inch
PVC	polyvinyl chloride
PWS	Performance Work Statement
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RFP	Request for Proposal
RO	reverse osmosis
RPD	relative percent difference
SDWA	Safe Drinking Water Act
SiO_2	silica
SMCL	secondary maximum contaminant level
SO_4^{2-}	sulfate
STS	Severn Trent Services
TCLP	Toxicity Characteristic Leaching Procedure

ABBREVIATIONS AND ACRONYMS (Continued)

TDS	total dissolved solids
Ti	titanium
TOC	total organic carbon
TSS	total suspended solids
U	uranium
V	vanadium
VOC	volatile organic compound
Zn	zinc

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1.0 INTRODUCTION

1.1 Background

The Safe Drinking Water Act (SDWA) mandates that the U.S. Environmental Protection Agency (EPA) identify and regulate drinking water contaminants that may have adverse human health effects and that are known or anticipated to occur in public water supply systems. In 1975, under the SDWA, EPA established a maximum contaminant level (MCL) for arsenic (As) at 0.05 mg/L. Amended in 1996, the SDWA required that EPA develop an arsenic research strategy and publish a proposal to revise the arsenic MCL by January 2000. On January 18, 2001, EPA finalized the arsenic MCL at 0.01 mg/L (EPA, 2001). In order to clarify the implementation of the original rule, EPA revised the rule text on March 25, 2003, to express the MCL as 0.010 mg/L (10 µg/L) (EPA, 2003). The final rule required all community and non-transient, non-community water systems to comply with the new standard by January 23, 2006.

In October 2001, EPA announced an initiative for additional research and development of cost-effective technologies to help small community water systems (<10,000 customers) meet the new arsenic standard, and to provide technical assistance to operators of small systems to reduce compliance costs. As part of this Arsenic Rule Implementation Research Program, EPA's Office of Research and Development (ORD) proposed a project to conduct a series of full-scale, on-site demonstrations of arsenic removal technologies, process modifications, and engineering approaches applicable to small systems. Shortly thereafter, an announcement was published in the *Federal Register* requesting water utilities interested in participating in Round 1 of this EPA-sponsored demonstration program to provide information on their water systems. In June 2002, EPA selected 17 out of 115 sites to host the demonstration studies.

In September 2002, EPA solicited proposals from engineering firms and vendors for cost-effective arsenic removal treatment technologies for the 17 host sites. EPA received 70 technical proposals for the 17 host sites, with each site receiving from one to six proposals. In April 2003, an independent technical panel reviewed the proposals and provided its recommendations to EPA on the technologies that it determined were acceptable for the demonstration at each site. Because of funding limitations and other technical reasons, only 12 of the 17 sites were selected for the demonstration project. Using the information provided by the review panel, EPA, in cooperation with the host sites and the drinking water programs of the respective states, selected one technical proposal for each site.

In 2003, EPA initiated Round 2 arsenic technology demonstration projects that were partially funded with Congressional add-on funding to the EPA budget. In June 2003, EPA selected 32 potential demonstration sites. In September 2003, EPA again solicited proposals from engineering firms and vendors for arsenic removal technologies. EPA received 148 technical proposals for the 32 host sites, with each site receiving from two to eight proposals. In April 2004, another technical panel was convened by EPA to review the proposals and provide recommendations to EPA with the number of proposals per site ranging from none (for two sites) to a maximum of four. The final selection of the treatment technology at the sites that received at least one proposal was made, again, through a joint effort by EPA, the state regulators, and the host site. Since then, four sites have withdrawn from the demonstration program, reducing the number of sites to 28.

With additional funding from Congress, EPA selected 10 more sites for demonstration under Round 2a. Among the sites selected was the Hot Springs Mobile Home Park (HSMHP) in Willard, Utah. Somewhat different from the Round 1 and Round 2 process, Battelle, under EPA's guidance, issued a Request for Proposal (RFP) on February 14, 2007, to solicit technology proposals from vendors and engineering firms. Upon closing of the RFP on April 13, 2007, Battelle received from 14 vendors a total of 44 proposals, which were reviewed by a three-expert technical review panel convened at EPA on May 2 and

3, 2007. Copies of the proposals and recommendations of the review panel were later provided to and discussed with representatives of the 10 host sites and state regulators in a technology selection meeting held at each host site during April through August 2007. Final selections of the treatment technology were made, again, through a joint effort by EPA, the respective state regulators, and the host sites. Adsorbsia™ GTO™ adsorptive media combined with a Birm®/Filox™ oxidizing media pretreatment was selected for demonstration at HSMHP in Willard, UT. The treatment system was provided by Filter Tech Systems, Inc. (Filter Tech) in Grand Junction, CO.

As of July 2011, all 50 systems were operational and the performance evaluations of 49 systems were completed.

1.2 Treatment Technologies for Arsenic Removal

Technologies selected for Rounds 1, 2, and 2a demonstration included adsorptive media (AM), iron removal (IR), coagulation/filtration (C/F), ion exchange (IX), reverse osmosis (RO), point-of-use (POU) RO, and system/process modification. Table 1-1 summarizes the locations, technologies, vendors, system flowrates, and key source water quality parameters (including As, iron [Fe], and pH). Table 1-2 presents the number of sites for each technology. AM technology was demonstrated at 30 sites, including four with IR pretreatment. IR technology was demonstrated at 12 sites, including four with supplemental iron addition. C/F, IX, and RO technologies were demonstrated at three, two, and one sites, respectively. The Sunset Ranch Development site that demonstrated POU RO technology had nine under-the-sink RO units. The Oregon Institute of Technology (OIT) site classified under AM had three AM systems and eight POU AM units. The Lidgerwood site encompassed only system/process modifications. An overview of the technology selection and system design for the 12 Round 1 demonstration sites and the associated capital costs is provided in two EPA reports (Wang et al., 2004; Chen et al., 2004), which are posted on the EPA Web site at http://www.epa.gov/ORD/NRMRL/arsenic/resource.htm.

1.3 Project Objectives

The objective of the arsenic demonstration program was to conduct full-scale performance evaluations of treatment technologies for arsenic removal from drinking water supplies. The specific objectives were to:

- Evaluate the performance of the arsenic removal technologies for use on small systems.
- Determine the required system operation and maintenance (O&M) and operator skill levels.
- Characterize process residuals produced by the technologies.
- Determine the capital and O&M cost of the technologies.

This report summarizes the performance of the arsenic removal system at the HSMHP in Willard, UT from December 11, 2008, through October 18, 2010. The types of data collected included system operation, water quality (both across the treatment train and in the distribution system), residuals, and capital and O&M cost.

Table 1-1. Summary of Rounds 1, 2, and 2a Arsenic Removal Demonstration Locations, Technologies, and Source Water Quality

Demonstration Location	Site Name	Technology (Media)	Vendor	Design Flowrate (gpm)	Source Water Quality As (µg/L)	Fe (µg/L)	pH (S.U.)
Northeast/Ohio							
Carmel, ME	Carmel Elementary School	RO	Norlen's Water	1,200 gpd	21	<25	7.9
Wales, ME	Springbrook Mobile Home Park	AM (A/I Complex)	ATS	14	38[a]	<25	8.6
Bow, NH	White Rock Water Company	AM (G2)	ADI	70[b]	39	<25	7.7
Goffstown, NH	Orchard Highlands Subdivision	AM (E33)	AdEdge	10	33	<25	6.9
Rollinsford, NH	Rollinsford Water and Sewer District	AM (E33)	AdEdge	100	36[a]	46	8.2
Dummerston, VT	Charette Mobile Home Park	AM (A/I Complex)	ATS	22	30	<25	7.9
Houghton, NY[c]	Town of Caneadea	IR (Macrolite)	Kinetico	550	27[a]	1,806[d]	7.6
Woodstock, CT	Woodstock Middle School	AM (Adsorbsia)	Siemens	17	21	<25	7.7
Pomfret, CT	Seely-Brown Village	AM (ArsenX^{np})	SolmeteX	15	25	<25	7.3
Felton, DE	Town of Felton	C/F (Macrolite)	Kinetico	375	30[a]	48	8.2
Stevensville, MD	Queen Anne's County	AM (E33)	STS	300	19[a]	270[d]	7.3
Conneaut Lake, PA	Conneaut Lake Park	IR (Greensand Plus) with ID	AdEdge	250	28[a]	157[d]	8.0
Buckeye Lake, OH	Buckeye Lake Head Start Building	AM (ARM 200)	Kinetico	10	15[a]	1,312[d]	7.6
Springfield, OH	Chateau Estates Mobile Home Park	IR & AM (E33)	AdEdge	250[e]	25[a]	1,615[d]	7.3
Great Lakes/Interior Plains							
Brown City, MI	City of Brown City	AM (E33)	STS	640	14[a]	127[d]	7.3
Pentwater, MI	Village of Pentwater	IR (Macrolite) with ID	Kinetico	400	13[a]	466[d]	6.9
Sandusky, MI	City of Sandusky	IR (Aeralater)	Siemens	340[e]	16[a]	1,387[d]	6.9
Delavan, WI	Vintage on the Ponds	IR (Macrolite)	Kinetico	40	20[a]	1,499[d]	7.5
Goshen, IN	Clinton Christian School	IR & AM (E33)	AdEdge	25	29[a]	810[d]	7.4
Fountain City, IN	Northeastern Elementary School	IR (G2)	US Water	60	27[a]	1,547[d]	7.5
Waynesville, IL	Village of Waynesville	IR (Greensand Plus)	Peerless	96	32[a]	2,543[d]	7.1
Geneseo Hills, IL	Geneseo Hills Subdivision	AM (E33)	AdEdge	200	25[a]	248[d]	7.4
Greenville, WI	Town of Greenville	IR (Macrolite)	Kinetico	375	17[a]	7,827[d]	7.3
Climax, MN	City of Climax	IR (Macrolite) with ID	Kinetico	140	39[a]	546[d]	7.4
Sabin, MN	City of Sabin	IR (Macrolite)	Kinetico	250	34[a]	1,470[d]	7.3
Sauk Centre, MN	Big Sauk Lake Mobile Home Park	IR (Macrolite)	Kinetico	20	25[a]	3,078[d]	7.1
Stewart, MN	City of Stewart	IR &AM (E33)	AdEdge	250	42[a]	1,344[d]	7.7
Lidgerwood, ND	City of Lidgerwood	Process Modification	Kinetico	250	146[a]	1,325[d]	7.2
Lead, SD	Terry Trojan Water District	AM (ArsenX^{np})	SolmeteX	75	24	<25	7.3
Midwest/Southwest							
Willard, UT	Hot Springs Mobile Home Park	IR & AM (Adsorbsia)	Filter Tech	30	15.4[a]	332[d]	7.5
Arnaudville, LA	United Water Systems	IR (Macrolite)	Kinetico	770[e]	35[a]	2,068[d]	7.0
Alvin, TX	Oak Manor Municipal Utility District	AM (E33)	STS	150	19[a]	95	7.8
Bruni, TX	Webb Consolidated Independent School District	AM (E33)	AdEdge	40	56[a]	<25	8.0
Wellman, TX	City of Wellman	AM (E33)	AdEdge	100	45	<25	7.7
Anthony, NM	Desert Sands Mutual Domestic Water Consumers Association	AM (E33)	STS	320	23[a]	39	7.7
Nambe Pueblo, NM	Nambe Pueblo Tribe	AM (E33)	AdEdge	145	33	<25	8.5

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Table 1-1. Summary of Rounds 1, 2, and 2a Arsenic Removal Demonstration Locations, Technologies, and Source Water Quality (Continued)

Demonstration Location	Site Name	Technology (Media)	Vendor	Design Flowrate (gpm)	Source Water Quality		
					As (µg/L)	Fe (µg/L)	pH (S.U.)
Taos, NM	Town of Taos	AM (E33)	STS	450	14	59	9.5
Rimrock, AZ	Arizona Water Company	AM (E33)	AdEdge	90[b]	50	170	7.2
Tohono O'odham Nation, AZ	Tohono O'odham Utility Authority	AM (E33)	AdEdge	50	32	<25	8.2
Valley Vista, AZ	Arizona Water Company	AM (AAFS50/ARM 200)	Kinetico	37	41	<25	7.8
Far West							
Three Forks, MT	City of Three Forks	C/F (Macrolite)	Kinetico	250	64	<25	7.5
Fruitland, ID	City of Fruitland	IX (A300E)	Kinetico	250	44	<25	7.4
Homedale, ID	Sunset Ranch Development	POU RO[f]	Kinetico	75 gpd	52	134	7.5
Okanogan, WA	City of Okanogan	C/F (Electromedia-I)	Filtronics	750	18	69[d]	8.0
Klamath Falls, OR	Oregon Institute of Technology	POE AM (Adsorbsia/ ARM 200/ArsenX^{np}) and POU AM (ARM 200)[g]	Kinetico	60/60/30	33	<25	7.9
Vale, OR	City of Vale	IX (Arsenex II)	Kinetico	525	17	<25	7.5
Reno, NV	South Truckee Meadows General Improvement District	AM (GFH)	Siemens	350	39	<25	7.4
Susanville, CA	Richmond School District	AM (A/I Complex)	ATS	12	37[a]	125	7.5
Lake Isabella, CA	Upper Bodfish Well CH2-A	AM (HIX)	VEETech	50	35	125	7.5
Tehachapi, CA	Golden Hills Community Service District	AM (Isolux)	MEI	150	15	<25	6.9

AM = adsorptive media process; C/F = coagulation/filtration; HIX = hybrid ion exchanger; IR = iron removal; IR with ID = iron removal with iron addition; IX = ion exchange process; RO = reverse osmosis

ATS = Aquatic Treatment Systems; MEI = Magnesium Elektron, Inc.; STS = Severn Trent Services

(a) Arsenic existing mostly as As(III).

(b) Design flowrate reduced by 50% due to system reconfiguration from parallel to series operation.

(c) Selected originally to replace Village of Lyman, NE site, which withdrew from program in June 2006; withdrew from program in 2007 and replaced with a home system in Lewisburg, OH.

(d) Iron existing mostly as Fe(II).

(e) Facilities upgraded systems in Springfield, OH from 150 to 250 gpm, Sandusky, MI from 210 to 340 gpm, and Arnaudville, LA from 385 to 770 gpm.

(f) Including nine residential units.

(g) Including eight under-the-sink units.

Table 1-2. Number of Demonstration Sites Under Each Arsenic Removal Technology

Technologies	Number of Sites
Adsorptive Media[(a)]	26
Adsorptive Media with Iron Removal Pretreatment	4
Iron Removal (Oxidation/Filtration)	8
Iron Removal with Supplemental Iron Addition	4
Coagulation/Filtration	3
Ion Exchange	2
Reverse Osmosis	1
Point-of-Use Reverse Osmosis[(b)]	1
System/Process Modifications	1

(a) OIT site at Klamath Falls, OR had three AM systems and eight POU AM units.

(b) Including nine under-the-sink RO units.

2.0 SUMMARY AND CONCLUSIONS

Based on the information collected during the 22 months of system operation, the following summary and conclusions were made relating to the overall objectives of the treatment technology demonstration study.

Performance of the arsenic removal technology for use on small systems:

- The use of Birm® in combination with Filox™ is effective in removing iron and manganese and oxidizing soluble As(III). No chemical addition or regeneration is required for Birm® or Filox™.
- A daily backwash for 8 min appears to be adequate to maintain Birm®/Filox™ media performance and prevent media fouling. Adsorbsia™ GTO™ media does not require backwash.
- Adsorbsia™ GTO™ media can effectively remove soluble As(V) to below 10 µg/L. By the last sampling event, total arsenic concentrations following Adsorbsia™ GTO™ reached 6.2 µg/L after treating approximately 69,200 bed volumes (BV) of water.

Required system O&M and operator skill levels:

- The system is simple to operate. The daily demand on the operator was typically 30 min to visually inspect the system and record operational parameters.

Process residuals produced by the technology:

- The only residual produced from system operation was Birm®/Filox™ backwash wastewater. The amount of wastewater produced amounted to about 10% of the water production, caused by a high backwashing frequency (i.e., daily).
- Based on an average of 29.8 mg/L of total suspended solids (TSS) in 752 gal of wastewater produced by backwashing the two vessels daily, approximately 85 g of solids would be discharged daily. The solids contained 102 mg of arsenic, 8.9 g of iron, and 1.6 g of manganese.

Capital and O&M cost of the technology:

- The unit capital cost was $0.40/1,000 gal of water treated if the system operated at a 100% utilization rate. The system's actual unit cost was $2.05/1,000 gal, based on a daily average water production of 8,354 gal (i.e., about 19% utilization).
- The O&M cost per 1,000 gal of water treated would be $2.20 plus the Adsorbsia™ GTO™ media replacement cost per actual run length.

3.0 MATERIALS AND METHODS

3.1 General Project Approach

Following the predemonstration activities summarized in Table 3-1, the performance evaluation study of the dual oxidizing media and Adsorbsia™ GTO™ arsenic removal system began on December 11, 2008, and ended on October 18, 2010. Table 3-2 summarizes the types of data collected and considered as part of the technology evaluation process. The overall system performance was evaluated based on its ability to consistently remove arsenic to below the MCL of 10 µg/L through the collection of water samples across the treatment train, as described in the Study Plan (Battelle, 2008). The reliability of the system was evaluated by tracking the unscheduled system downtime and frequency and extent of repair and replacement. The plant operator recorded unscheduled downtime and repair information on a Repair and Maintenance Log Sheet.

Table 3-1. Predemonstration Study Activities and Completion Dates

Activity	Date
Introductory Meeting Held	November 30, 2006
Technology Selection Meeting Held	June 20, 2007
Project Planning Meeting Held	September 18, 2007
Draft Letter of Understanding Issued	November 5, 2007
Final Letter of Understanding Issued	November 21, 2007
Request for Quotation Issued to Vendor	January 30, 2008
Vendor Quotation Received by Battelle	April 5, 2008
Purchase Order Completed and Signed	May 27, 2008
Engineering Package Submitted to Utah DDW	July 7, 2008
Permit Issued by Utah DDW	August 7, 2008
Equipment Arrived at Site	September 16, 2008
Final Study Plan Issued	September 24, 2008
System Installation Completed	October 24, 2008
System Shakedown Completed	October 31, 2008
Performance Evaluation Begun	December 11, 2008

DDW = Division of Drinking Water

The O&M and operator skill requirements were evaluated based on a combination of quantitative data and qualitative considerations, including the need for pre- and/or post-treatment, level of system automation, extent of preventative maintenance activities, frequency of chemical and/or media handling and inventory, and general knowledge needed for relevant chemical processes and related health and safety practices. The staffing requirements for the system operation were recorded on an Operator Labor Hour Log Sheet.

The quantity of aqueous and solid residuals generated was estimated by tracking the volume of backwash wastewater produced during each backwash cycle. Backwash wastewater and solids were sampled and analyzed for chemical characteristics.

The cost of the system was evaluated based on the capital cost per gal/min (gpm) (or gal/day [gpd]) of design capacity and the O&M cost per 1,000 gal of water treated. This task required tracking the capital

Table 3-2. Evaluation Objectives and Supporting Data Collection Activities

Evaluation Objectives	Data Collection
Performance	–Ability to consistently meet 10-µg/L arsenic MCL in treated water
Reliability	–Unscheduled system downtime –Frequency and extent of repairs including a description of problems encountered, materials and supplies needed, and associated labor and cost incurred
System O&M and Operator Skill Requirements	–Pre- and post-treatment requirements –Level of automation for system operation and data collection –Staffing requirements including number of operators and laborers –Task analysis of preventative maintenance including number, frequency, and complexity of tasks –Chemical handling and inventory requirements –General knowledge needed for relevant chemical processes and health and safety practices
Residual Management	–Quantity and characteristics of aqueous and solid residuals generated by system operation
Cost-Effectiveness	–Capital cost for equipment, engineering, and installation –O&M cost for chemical usage, electricity consumption, and labor

cost for equipment, engineering, and installation, as well as the O&M cost for media replacement and disposal, chemical supply, electrical usage, and labor.

3.2 System O&M and Cost Data Collection

The plant operator performed daily, biweekly, and monthly system O&M and data collection according to instructions provided by the vendor and Battelle. On a regular basis, the plant operator recorded system operational data such as pressure, flowrate, totalizer, and hour meter readings on a System Operation Log Sheet and conducted visual inspections to ensure normal system operations. When problems occurred, the plant operator contacted the Battelle Study Lead, who determined if the vendor should be contacted for troubleshooting. The plant operator recorded all relevant information, including the problems encountered, course of actions taken, materials and supplies used, and associated cost and labor incurred on the Repair and Maintenance Log Sheet. On a regular basis, the plant operator also measured temperature, pH, dissolved oxygen (DO), and oxidation-reduction potential (ORP) and recorded the data on an Onsite Water Quality Parameters Log Sheet.

The capital cost for the arsenic removal system consisted of the cost for equipment, site engineering, and system installation. The O&M cost consisted of the cost for electricity consumption, and labor. Labor for various activities, such as the routine system O&M, troubleshooting and repairs, and demonstration-related work, was tracked using an Operator Labor Hour Log Sheet. The routine system O&M included activities such as completing field logs, performing system inspections, and others as recommended by the vendor. The labor for demonstration-related work, including activities such as performing field measurements, collecting and shipping samples, and communicating with the Battelle Study Lead and the vendor, was recorded, but not used for cost analysis.

3.3 Sample Collection Procedures and Schedules

To evaluate system performance, samples were collected from the wellhead, across the treatment plant, during oxidation/filtration vessel backwash, and from the distribution system. Table 3-3 presents the

Table 3-3. Sampling Schedule and Analytes

Sample Type	Sample Locations[a]	No. of Samples	Frequency	Analytes	Sampling Date
Source Water	IN	1	Once (during initial site visit)	Onsite: pH, temperature, DO, and ORP Offsite: As (III), As(V), As (total and soluble), Fe (total and soluble), Mn (total and soluble), Sb (total and soluble), V (total), Na, Ca, Mg, Cl, F, NO_3, NO_2, NH_3, SO_4, SiO_2, turbidity, alkalinity, TDS, and TOC	11/30/06
Treatment Plant Water	IN, TA, TB, AP, and TC	5[b]	Monthly[c,d] (Speciation sampling)	Onsite: pH, temperature, DO, and/or ORP Offsite: As(III), As(V), As (total and soluble), Fe (total and soluble), Mn (total and soluble), Ti (total and soluble), Ca, Mg, F, NO_3, SO_4, SiO_2, P (total), turbidity, and alkalinity	See Appendix B
			Weekly from 01/28/09 to 11/04/09[e], none in 12/09 and 01/10, and monthly thereafter (regular sampling)	Onsite: Same as above Offsite: As (total), Fe (total), Mn (total), Ti (total), SiO_2, turbidity, and alkalinity	See Appendix B
Distribution System Water[f]	Mobile homes	3	Monthly to 11/04/09	Total As, Fe, Mn, Cu, and Pb, pH, and alkalinity	See Table 4-13
Backwash Wastewater	Backwash discharge line (BW)	2	Monthly	pH, TDS, TSS, As (total and soluble), Fe (total and soluble), Mn (total and soluble), and Ti (total and soluble)	See Table 4-11
Backwash Solids	Wastewater container	2	Once	Al, As, Ba, Ca, Cd, Cu, Fe, Mg, Mn, Ni, P, Pb, Si, Zn	06/29/09

(a) Abbreviations in parenthesis corresponding to sample locations shown in Figure 4-6, i.e., IN = at wellhead; TA= after pre-oxidation vessel A; TB = after pre-oxidation vessel B; AP = after Vessels A and B combined; TC= after adsorption vessel; DS = distribution system; BW = backwash discharge line

(b) Sampled at IN, TA, TB, AP, and TC from 12/17/08 through 02/18/09 and at IN, AP, and TC thereafter.

(c) Except for June 2009 and June 2010 (with two speciation sampling events taking place in each month) and August 2010 (with no speciation sampling taking place).

(d) On 03/10/09, samples collected at IN, TA, TB and TC.

(e) On 12/17/08, only total metals were sampled.

(f) Four baseline sampling events taking place from July 16 to September 2, 2008, before system startup.

DO = dissolved oxygen; ORP = oxidation-reduction potential; TDS = total dissolved solids; TSS = total suspended solids sampling schedules and analytes measured during each sampling event. Specific sampling requirements for analytical methods, sample volumes, containers, preservation, and holding times are presented in Table 4-1 of the EPA-endorsed Quality Assurance Project Plan (QAPP) (Battelle, 2007). The procedure for arsenic speciation is described in Appendix A of the QAPP.

3.3.1 Source Water. During the introductory meeting on November 30, 2006, one set of source water samples was collected from Well No. 2 and speciated using an arsenic specitation kit (see Section 3.4.1). The sample taps were flushed for several minutes before sampling; special care was taken to avoid agitation, which might have caused unwanted oxidation. Analytes for the source water samples are listed in Table 3-3.

3.3.2 Treatment Plant Water. The first treatment-plant sampling event occurred on December 17, 2008, when samples were collected for only total metal analysis. The next sampling event occurred on January 22, 2009, during Battelle's site visit and operator training. Since then through the end of the performance evaluation study, treatment plant water samples were collected from weekly to monthly, somewhat different from the schedule laid out in the Battelle Study Plan (2008). The Study Plan called for weekly sampling, with "speciation sampling" performed during the first week of each four-week cycle at the wellhead (IN), after the two pre-oxidation vessels (AP), and after the adsorption vessel (TC); and "regular sampling" performed during the second, third, and fourth weeks at IN, after Pre-oxidation Vessel A (TA), after Pre-oxidation Vessel B (TB), and TC. Speciation sampling included onsite speciation for total and soluble arsenic, iron, manganese, and titanium, and a suite of analytes as listed under "Speciation Sampling" in Table 3-3; regular sampling included total arsenic, iron, manganese, and titanium and silica, turbidity and alkalinity as listed in Table 3-3.

Actual speciation sampling occurred monthly, with three exceptions for the month of June 2009 and June 2010 (with two speciation sampling events taking place in each month) and the month of August 2010 (with no speciation sampling taking place). Actual regular sampling occurred as called for by the Study Plan from February 22, 2009, through November 18, 2009, except for the weeks of July 21 and November 11, 2009, when no sampling took place during these two weeks. Regular sampling was discontinued during the months of December 2009 and January 2010 but resumed in February 2010 with a monthly frequency until the end of the performance evaluation study.

Treatment plant water samples were collected at IN, TA, TB, AP, and TC from December 17, 2008, through February 18, 2009, and at IN, AP, and TC thereafter (except for the week of March 10, 2009, when samples were taken from IN, TA, TB, and TC).

Beginning on April 19, 2010, only total arsenic, iron, manganese, and titanium were analyzed during each regular sampling event.

3.3.3 Backwash Wastewater and Solids. The plant operator collected backwash wastewater samples from each oxidation/filtration vessel on 12 occasions. During backwash, a side stream of backwash wastewater was directed from the tap on the backwash water discharge line to a clean, 32-gal plastic container at approximately 1 gpm (Figure 3-1). After the contents in the container were thoroughly mixed, one aliquot was collected as is and the other filtered with 0.45-μm disc filters. The samples were analyzed for analytes listed in Table 3-3.

Once during the study period, the contents in the 32-gal plastic container were allowed to settle and the supernatant was carefully siphoned using a piece of plastic tubing to avoid agitation of settled solids in the container. The remaining solids/water mixture was then transferred to a 1-gal plastic jar. After solids in the jar settled and the supernatant was carefully decanted, one aliquot of the solids/water mixture was air-dried before being acid-digested and analyzed for the metals listed in Table 3-3.

Figure 3-1. Backwash Sampling

3.3.4 Spent Media. The media in the oxidation/filtration and adsorption vessels were not replaced during this demonstration study, therefore, no spent media were produced as residual solids.

3.3.5 Distribution System Water. Water samples were collected from the distribution system to determine the impact of the arsenic treatment system on the water chemistry in the distribution system, specifically, the arsenic, lead and copper levels. Prior to the system startup from July 16 to September 2, 2008, four sets of baseline distribution system water samples were collected at three locations (845 West 8700 South House, 845 West 8700 South No. 1, and 845 West 8700 South No. 2). Following system startup, distribution system sampling continued periodically at the same sampling locations.

The plant operator collected the samples following an instruction sheet developed in accordance with the *Lead and Copper Monitoring and Reporting Guidance for Public Water Systems* (EPA, 2002). The date and time of last water usage before sampling and of actual sample collection were recorded for calculation of stagnation time. All samples were collected from a cold-water faucet that had not been used for 6 hr or greater to ensure that stagnant water was sampled.

3.4 Sampling Logistics

3.4.1 Preparation of Arsenic Speciation Kits. The arsenic field speciation method used an anion exchange resin column to separate the soluble arsenic species, As(V) and As(III) (Edwards et al., 1998). Resin columns were prepared in batches at Battelle laboratories in accordance with the procedures detailed in Appendix A of the EPA-endorsed QAPP (Battelle, 2007).

3.4.2 Preparation of Sampling Coolers. For each sampling event, a sample cooler was prepared with the appropriate number and type of sample bottles, disc filters, and/or speciation kits. All sample bottles were new and contained appropriate preservatives. Each sample bottle was affixed with a pre-printed, color-coded label consisting of sample identification (ID), date and time of sample collection, collector's name, site location, sample destination, analysis required, and preservative. The sample ID consisted of a two-letter code for a specific water facility, sampling date, a two-letter code for a specific sampling location, and a one-letter code designating the arsenic speciation bottle (if necessary). The sampling locations at the treatment plant were color-coded for easy identification. The labeled bottles for each sampling location were placed in separate zip-lock bags and packed in the cooler.

In addition, all sampling- and shipping-related materials, such as disposable gloves, sampling instructions, chain-of-custody forms, prepaid/addressed FedEx air bills, and bubble wrap, were included. The chain-of-custody forms and air bills were complete except for the operator's signature and the sample dates and times. After preparation, the sample cooler was sent to the site via FedEx for the following week's sampling event.

3.4.3 Sample Shipping and Handling. After sample collection, samples for offsite analyses were packed carefully in the original coolers with wet ice and shipped to Battelle. Upon receipt, the sample custodian verified that all samples indicated on the chain-of-custody forms were included and intact. Sample IDs were checked against the chain-of-custody forms, and the samples were logged into the laboratory sample receipt log. Discrepancies noted by the sample custodian were addressed with the plant operator by the Battelle Study Lead.

Samples for metals analyses were stored at Battelle's inductively coupled plasma-mass spectrometry (ICP-MS) laboratory. Samples for other water analyses were packed in separate coolers and picked up by couriers from American Analytical Laboratories (AAL) in Columbus, OH, which was under contract with Battelle for this demonstration study. The chain-of-custody forms remained with the samples from the time of preparation through analysis and final disposition. All samples were archived by the appropriate laboratories for the respective duration of the required hold time and disposed of properly thereafter.

3.5 Analytical Procedures

The analytical procedures described in detail in Section 4.0 of the EPA-endorsed QAPP (Battelle, 2007) were followed by Battelle's ICP-MS laboratory and AAL. Laboratory quality assurance/quality control (QA/QC) of all methods followed the prescribed guidelines. Data quality in terms of precision, accuracy, method detection limits (MDLs), and completeness met the criteria established in the QAPP (i.e., relative percent difference [RPD] of 20%, percent recovery of 80 to 120%, and completeness of 80%). The QA data associated with each analyte will be presented and evaluated in a QA/QC Summary Report to be prepared under separate cover upon completion of the Arsenic Demonstration Project.

Field measurements of pH, temperature, DO, and ORP were conducted by the plant operator using a VWR Symphony SP90M5 Handheld Multimeter, which was calibrated for pH and DO prior to use following the procedures provided in the user's manual. The ORP probe also was checked for accuracy by measuring the ORP of a standard solution and comparing it to the expected value. The plant operator collected a water sample in a clean, plastic beaker and placed the Symphony SP90M5 probe in the beaker until a stable value was obtained.

4.0 RESULTS AND DISCUSSION

4.1 Facility Description and Pre-existing Treatment System Infrastructure

HSMHP is located at 845 West 8700 South in Willard, UT. The facility is a community water system (CWS) supplied by two artesian wells, i.e., Wells No. 1 and No. 2. Well No. 1 has not been used for the past 10 years and is intended only as a backup well. Designated for this demonstration study, Well No. 2 served a population of 110 to 125 residents. Prior to the study, this well typically operated 5 to 6 hr/day to meet the average daily demand of approximately 11,000 gal.

Well No. 2 was 10-in in diameter and 288 ft deep with a screened interval extending from 200 to 250 ft below ground surface (bgs). The static water level was 8 ft bgs. The well was equipped with a 2-horsepower (hp) submersible pump rated for 30 gpm. The pre-existing Well No. 2 pump house was a 8 ft × 10 ft × 8 ft wooden shed (Figure 4-1), which housed the wellhead cavity, piping, and a sample tap (Figure 4-2). Various instrumentation, including pressure gauges and a wellhead totalizer, also was located inside the pump house. There was no pre-existing treatment at this site. Two hydropneumatic tanks (Figure 4-3) were used to maintain the line pressure at 35 to 60 lb/in^2 (psi). Water entered the distribution system via a 500-gal underground storage tank (that was also pressurized).

Figure 4-1. Existing Pump House at HSMHP

Figure 4-2. Wellhead Cavity and Piping in Pump House

Figure 4-3. Hydropneumatic Tanks in Pump House

4.1.1 Source Water Quality. Source water samples from Well No. 2 were collected on November 30, 2006, when Battelle staff traveled to the site to conduct an introductory meeting for this demonstration project. The source water was filtered for soluble arsenic, iron, manganese, and antimony, and then speciated for As(III) and As(V) using field arsenic speciation kits. In addition, pH, temperature, DO, and ORP also were measured onsite using a field meter. Table 4-1 presents analytical results from the source water sampling, which are compared to the data provided by EPA and Utah DDW. Table 4-2 presents year 2000 to 2005 source water quality data provided by Utah DDW.

Table 4-1. HSMHP Well No. 2 Source Water Data

Parameter	Unit	EPA Data	Battelle Data	Utah DDW Historical Data[(a)]
Date		03/20/06	11/30/06	12/00–12/05
pH	S.U.	NA	7.5	NA
Temperature	°C	NA	15.5	NA
DO	mg/L	NA	2.3	NA
ORP	mV	NA	285	NA
Total Alkalinity (as $CaCO_3$)	mg/L	NA	137	NA
Total Hardness (as $CaCO_3$)	mg/L	112	108	NA
Turbidity	NTU	NA	2.6	1.4–1.7
Total Dissolved Solids (TDS)	mg/L	NA	172	180–288
Total Organic Carbon (TOC)	mg/L	NA	<1	NA
Nitrate (as N)	mg/L	NA	0.2	0.2–0.3
Nitrite (as N)	mg/L	NA	<0.05	<0.1
Ammonia (as N)	mg/L	NA	0.05	NA
Chloride	mg/L	NA	23	NA
Fluoride	mg/L	NA	<0.1	<0.1
Sulfate	mg/L	6.8	6.0	7.0–9.0
Silica (as SiO_2)	mg/L	13.4	13.3	NA
Orthophosphate (as PO_4)	mg/L	0.2	NA	NA
P (as PO_4)	mg/L	0.4	NA	NA
Al (total)	μg/L	<25	NA	NA
As (total)	μg/L	12	15.4	13–14
As (soluble)	μg/L	NA	13.6	NA
As (particulate)	μg/L	NA	1.8	NA
As(III)	μg/L	NA	6.0	NA
As(V)	μg/L	NA	7.6	NA
Fe (total)	μg/L	213	332	NA
Fe (soluble)	μg/L	NA	129	NA
Mn (total)	μg/L	130	180	NA
Mn (soluble)	μg/L	NA	165	NA
Sb (total)	μg/L	NA	<0.1	<0.5
Sb (soluble)	μg/L	NA	<0.1	NA
V (total)	μg/L	NA	4.3	NA
Na (total)	mg/L	31.9	32.2	28–48
Ca (total)	mg/L	37.5	35.6	NA
Mg (total)	mg/L	4.6	4.7	NA

(a) See Table 4-2 for detailed data
DDW = Division of Drinking Water; NA = not available

Table 4-2. HSMHP Historic Water Quality Data

Parameter	Unit	Well No. 2				
	Date	12/19/00	12/12/01	12/13/02	12/08/03	12/07/05
Fluoride	mg/L	<0.10	NS	NS	<0.10	NS
Sulfate	mg/L	7	NS	NS	9	NS
Nitrate (as N)	mg/L	0.2	0.3	0.2	0.2	0.2
Nitrite (as N)	mg/L	<0.01	NS	<0.10	NS	NS
Turbidity	NTU	1.4	NS	NS	1.7	NS
TDS	mg/L	180	NS	NS	288	NS
Antimony	μg/L	<0.5	NS	NS	<0.5	NS
Arsenic	μg/L	14	NS	NS	13	NS
Barium	mg/L	0.07	NS	NS	0.12	NS
Beryllium	μg/L	<1.0	NS	NS	<1.0	NS
Cadmium	μg/L	<1	NS	NS	<1	NS
Chromium	μg/L	<5.0	NS	NS	<5.0	NS
Cyanide	μg/L	<2.0	NS	NS	<2.0	NS
Mercury	μg/L	<0.2	NS	NS	<0.2	NS
Nickel	μg/L	<10.0	NS	NS	<10.0	NS
Selenium	μg/L	<0.5	NS	NS	0.9	NS
Sodium	mg/L	28	NS	NS	48	NS
Thallium	μg/L	<0.5	NS	NS	<0.5	NS
Gross Alpha	pCi/L	NS	NS	NS	<2	NS
Gross Beta	pCi/L	NS	NS	NS	<3	NS

Source: Utah Division of Drinking Water
NS = not sampled

Several factors, such as arsenic concentration and species, natural iron concentration, pH, natural organic matter, and competing anions, affected the treatment train chosen. The results of the source water assessment and implications for water treatment are discussed briefly below.

Arsenic. Historically, total arsenic concentrations of source water ranged from 13 to 14 μg/L. Based on Battelle's sampling results, out of 15.4 μg/L of total arsenic, 1.8 μg/L existed as particulate arsenic. For the soluble fraction, 6.0 μg/L existed as As(III) and 7.6 μg/L existed as As(V). A pre-oxidation step, therefore, was needed to convert soluble As(III) to soluble As(V) for more effective arsenic removal. No prior information on arsenic speciation was available. Battelle and EPA's total arsenic results were slightly higher and lower, respectively, than the historical range provided by Utah DDW.

Iron and Manganese. No historical data on iron concentrations existed. Battelle's data indicated that, out of 332 μg/L of total iron measured (which was over the 300-μg/L secondary maximum contaminant level [SMCL]), only 129 μg/L (or 38%) existed as soluble iron, which was about 10 times higher than soluble arsenic. EPA's March 20, 2006 sampling event indicated 213 μg/L of iron in raw water, which was slightly lower than Battelle's data (EPA's data did not include soluble iron concentration). Manganese concentrations of 130 and 180 μg/L obtained by EPA and Battelle, respectively, also exceed the SMCL of 50 μg/L. The presence of iron and manganese as well as soluble As(III) in raw water required pre-oxidation of water prior to Adsorbsia™ GTO™ adsorption.

Competing Anions. Depending on the treatment technology, removal of arsenic potentially can be influenced by competing anions such as silica and phosphorus. Concentrations of silica at 13.3 to 13.4 mg/L (as SiO_2) in raw water is not considered high enough to impact adsorption by Adsorbsia™ GTO™

media. Phosphorus concentrations were 0.2 mg/L (as PO_4) or 0.4 mg/L (as P) based on EPA data. This level of phosphorus could impact arsenic removal by iron-based media, but not by Adsorbsia™ GTO™ according to the media manufacturer, The Dow Chemical Company (Dow).

Other Water Quality Parameters. Battelle's data indicate a moderate pH of 7.5, which is within the commonly-agreed target range of 5.5 to 8.5 for arsenic removal. The raw water samples also were analyzed for additional parameters as listed in Tables 4-1 and 4-2. Collectively, total hardness concentrations ranged from 108 to 112 mg/L (as $CaCO_3$); turbidity from 1.4 to 2.6 nephelometric turbidity unit (NTU); total dissolved solids (TDS) from 172 to 288 mg/L; nitrate from 0.2 to 0.3 mg/L; barium from 0.07 to 0.12 mg/L; selenium from <0.5 to 0.9 μg/L; and sodium from 28 to 48 mg/L. All other analytes were below detection limits and/or anticipated to be low enough not to adversely affect the arsenic removal process.

4.1.2 Distribution System. The distribution system for HSMHP consisted of 46 connections. According to the park owner, the distribution system material is comprised of 2-in diameter galvanized main with ¾-in galvanized connections to each home. Three residences within the mobile home park were selected for monthly baseline and distribution system water sampling to evaluate the effect of the treatment system on the distribution system water quality.

For compliance purposes, HSMHP samples water periodically from the distribution system for several parameters: monthly for bacterial analysis; yearly for nitrate; once every three years for lead and copper, volatile organic compounds (VOCs), and inorganics; and once every three to five years for pesticides.

4.2 Treatment Process Description

4.2.1 Technology Description. Adsorbsia™ GTO™ media was proposed by Filter Tech to remove arsenic at HSMHP. To protect the media from fouling and to extend media life, a decision was made to pretreat iron and manganese and to oxidize soluble As(III) to soluble As(V). Because HSMHP preferred not to use any chemicals, such as chlorine, to oxidize and disinfect water due to its concerns over changing the taste of water and chemical handling, a pretreatment system of Birm® over Filox™ was added to the originally proposed Adsorbsia™ GTO™ system. The use of an iron sequester, such as polyphosphate, had been suggested, but not adopted because it would not oxidize soluble As(III) and could potentially impact arsenic adsorption with Adsorbsia™ GTO™. Based upon results of a pilot study conducted at Licking Valley High School in Newark, OH under a separate EPA Task Order, EPA/Battelle proposed to use the dual oxidizing media, Birm® and Filox™, to remove iron and manganese and simultaneously oxidize soluble As(III) in source water. Upon acceptance of the approach by all project stakeholders, including UTAH DDW, HSMHP, and Filter Tech, Filter Tech revised its original design to include Birm®/Filox™ as a pretreatment.

The treatment system at HSMHP consisted of two steps: oxidation/filtration of iron and manganese and oxidation of soluble As(III) with Birm® and Filox™ followed by adsorption of soluble As(V) with Adsorbsia™ GTO™. Backwashing as frequently as daily would be required to remove iron and manganese solids accumulated in the Birm® and Filox™ media bed and maintain the effectiveness of the media. This high backwashing frequency was considered important because of the high levels of iron and manganese. After the oxidation of soluble As(III), water containing soluble As(V) was introduced downward through the Adsorbsia™ GTO™ bed. When the media reached its capacity, the spent media would be removed and subject to EPA's Toxicity Characteristic Leaching Procedure (TCLP) before disposal. The media life depends upon soluble As(V) concentration, pH, and concentrations of competing anions in source water.

4.2.2 Birm® and Filox™. Birm® is an acronym that stands for the "Burgess Iron Removal Method" and is a proprietary product manufactured by the Clack Corporation (Windsor, Wisconsin). Birm® is produced by impregnating manganous salts to near saturation on aluminum silicate sand, a base material, followed by oxidizing manganous ions to solid manganese dioxide using potassium permanganate. Filox™ is a brand name for pyrolusite, a naturally-occurring manganese dioxide (MnO_2) in granular form. Both media can oxidize soluble Fe(II) and soluble Mn(II) and trap precipitated particles in media beds. Both media have NSF International (NSF) Standard 61 approval for use in drinking water. Table 4-3 presents physical and chemical properties of Birm® and Filox™. When used in a mixed bed, Filox™ stays in the lower half of the bed and Birm® over the upper half because the density of Filox™ is over double the density of Birm®. As well water is applied downward through the bed, Birm® will oxidize most of the soluble Fe(II) and soluble Mn(II), leaving soluble As(III) to be oxidized by Filox™. This is based on observations made during the above-mentioned pilot study.

Table 4-3. Physical and Chemical Properties of Birm® and Filox™ Media

Media	Birm®	Filox™
Color	Black	Black
Active Ingredient (wt%)	$<0.01\%$ MnO_2	75–85% MnO_2
Mesh Size	10×40	20×40
Effective Size (mm)	0.48	Not Available
Bulk Density (g/L)	681	1,826
Bulk Density (lb/ft^3)	40–45	114
Specific Gravity	2	NA
Uniformity Coefficient	2.7	1.45
pH Range	6.8–9.0	5.0–9.0
Source	Clack Corporation	Matt-Son, Inc.

4.2.3 Adsorbsia™ GTO™ Media. Adsorbsia™ GTO™ is a white, free flowing granular titanium oxide-based media manufactured by Dow. The media is capable of adsorbing both soluble As(V) and soluble As(III), with a higher capacity for soluble As(V). Commonly mentioned adsorption pH values range from 6.5 to 8.5, but the adsorption is less effective at the upper end of the range. According to Dow, the media capacity for arsenic may be independent of anions such as sulfate, phosphate, and vanadium. However, the presence of silica can reduce arsenic removal. Adsorbsia™ GTO™ is designed for non-regenerative applications. When exhausted, it is removed from the vessel and replaced with virgin media. Spent media from Dow's arsenic loading tests have been shown to pass both the TCLP and California Waste Extraction Test (CA WET). Table 4-4 presents physical and chemical properties of Adsorbsia™ GTO™. The media is NSF/ANSI 61 certified and delivered in dry granular form.

4.2.4 System Design and Treatment Process. The 30-gpm treatment system consisted of two Birm®/Filox™ vessels, one Adsorbsia™ GTO™ vessel, one backwash water supply tank, and two pressure tanks (pre-existing). Figure 4-4 presents a schematic of the treatment system. Figure 4-5 shows as-built cross sections of a pre-oxidizing and an adsorption vessel. Table 4-5 specifies key system design parameters of the treatment system. Figure 4-6 shows a process flowchart, along with the sampling/ analysis schedule. The key process components of the treatment system are discussed as follows:

- **Intake** – Raw water was fed to the treatment system by a 2-hp submersible pump with a maximum flowrate of 30 gpm. The reported deadhead pump pressure was 50 psi (on average), based on a pre-existing pressure gauge installed at the wellhead. A pre-existing flow meter/totalizer was used to monitor flowrates and volume throughputs. A sample tap was used to collect raw water samples for chemical analysis.

Table 4-4. Physical and Chemical Properties of Adsorbsia™ GTO™ Media

Parameter	Value
Product Type	Titanium oxide based granulation
Particle Size Range (mesh)	10–60
Moisture Content (%)	<15
Bulk Density (g/L)	705
Bulk Density (lb/ft^3)	44
Specific Surface Area (m^2/g)	200–300
Pore Volume (cm^3/g)	0.20–0.25
Equilibrium Capacity[a] (@ 50 ppb, pH 7)	
Arsenic (V) (mg/g)	12–15
Arsenic (III) (mg/g)	3–4

Source: The Dow Chemical Company

(a) Static equilibrium capacity measured at room temperature in NSF Standard 53 challenge water.

- **Pre-Oxidation** – Prior to adsorption, raw water was allowed to flow through two 24-in × 72-in, in-parallel composite vessels, each containing 19 in of Birm® and 19 in of Filox™. At a design flowrate of 15 gpm/vessel, it corresponds to a filtration rate of 4.8 gpm/ft^2, which is within the recommended range of 3 to 5 gpm/ft^2. During media backwashing, a 15-gpm/ft^2 backwash rate was applied to the bed, resulting in >40% and <10% bed expansion for Birm® and Filox™, respectively. These anticipated bed expansions were well within the 30 in available freeboard in each pre-oxidation vessel (actual freeboard was <30 in).

  The anticipated pressure drop across a clean bed was 4 psi, and the maximum pressure drop allowed was 14 psi. Pressure gauges and sample taps located before and after each pre-oxidation vessel were used to monitor pressure drop and effectiveness of pre-oxidation, respectively. Flowrates and volume throughputs of filtered water were monitored with two 1½-in Signet battery-operated insertion turbine meters/totalizers located on the effluent side of the two pre-oxidation vessels. Figure 4-7 shows the two pre-oxidation vessels (Vessels A and B) and one adsorption vessel (Vessel C) and piping connections. Figure 4-8 shows the programmable logic controller (PLC) panel with a close-up view of the touch screen for the filter operation.

- **Adsorption** – Following pre-oxidation, water was fed to a 24-in × 72-in composite vessel containing 10 ft^3 of Adsorbsia™GTO™ underlain by 2 ft^3 of garnet. At the design flow rate of 30 gpm, the empty bed contact time (EBCT) was 2.5 min and the hydraulic loading rate was 9.5 gpm/ft^2. The anticipated pressure drop across a clean bed was 8 psi, and the maximum pressure drop was 18 psi. Flowrates and volume throughputs of treated water were monitored using a 1½-in Signet battery-operated insertion turbine meter/totalizer located on the effluent side of the vessel. The head loss across the vessel was monitored by a pair of pressure gauges. A strainer (Figure 4-9) was installed before the adsorption vessel to capture fines exiting the pre-oxidation vessels. Sample taps were located before and after the pressure vessel to allow for the collection of water samples for chemical analyses.

- **Pressure Tanks** – Treated water from Vessel C was temporarily stored in the two pre-existing pressure tanks (Figure 4-3) in the Well No. 2 pump house. These pressure tanks were used to maintain the line pressure between 35 and 60 psi.

- **Filter Backwash** – Frequent backwashing was required to maintain performance of the pre-oxidizing media. Upon initiation by a time setpoint, backwash was done with Birm®/Filox™-treated water stored in a 550-gal poly tank (Figure 4-10). During system startup and shakedown, programming changes were made to include a time delay between

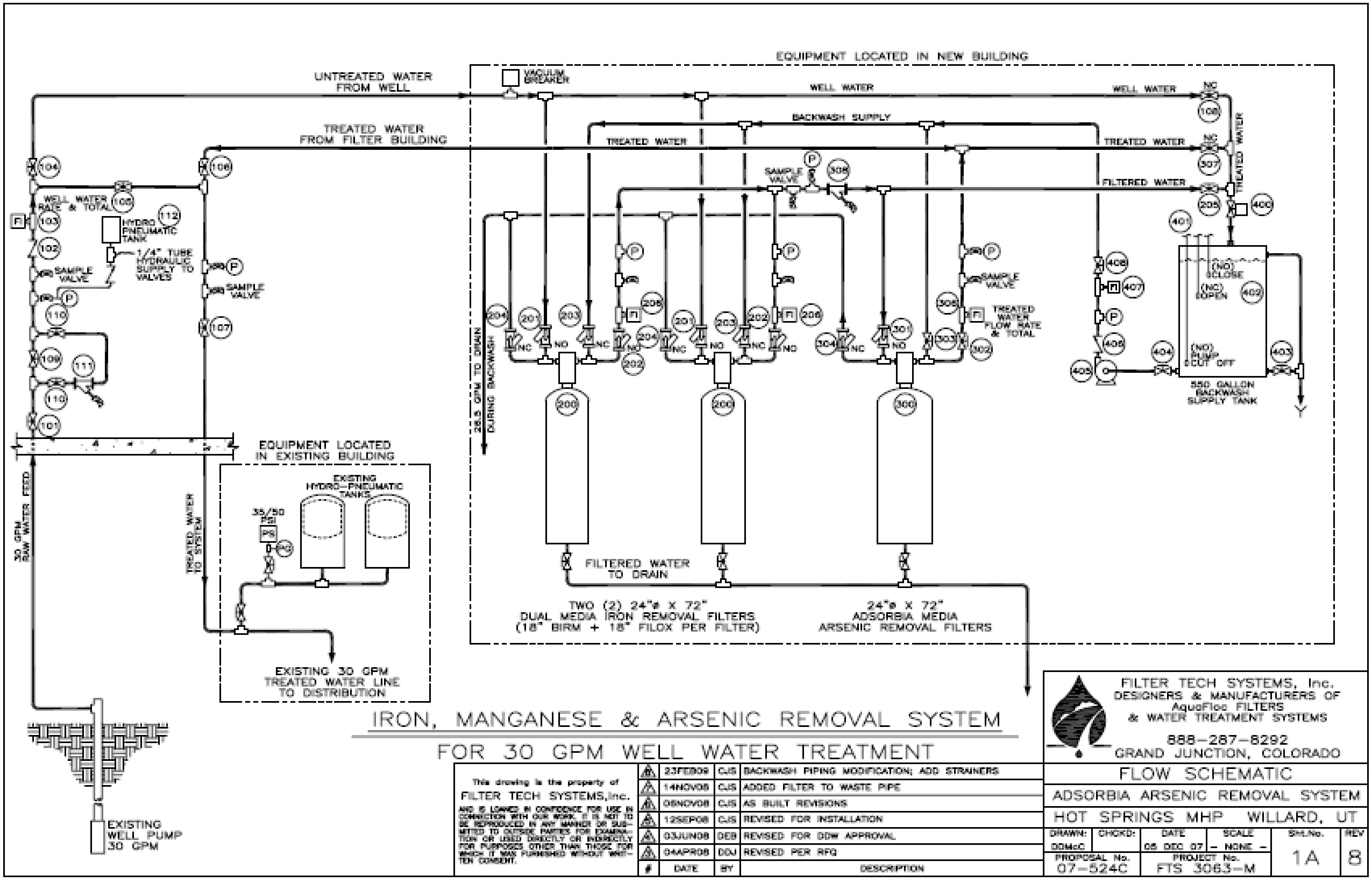


Figure 4-4. Schematic of Pre-Oxidation and Adsorptive Media System

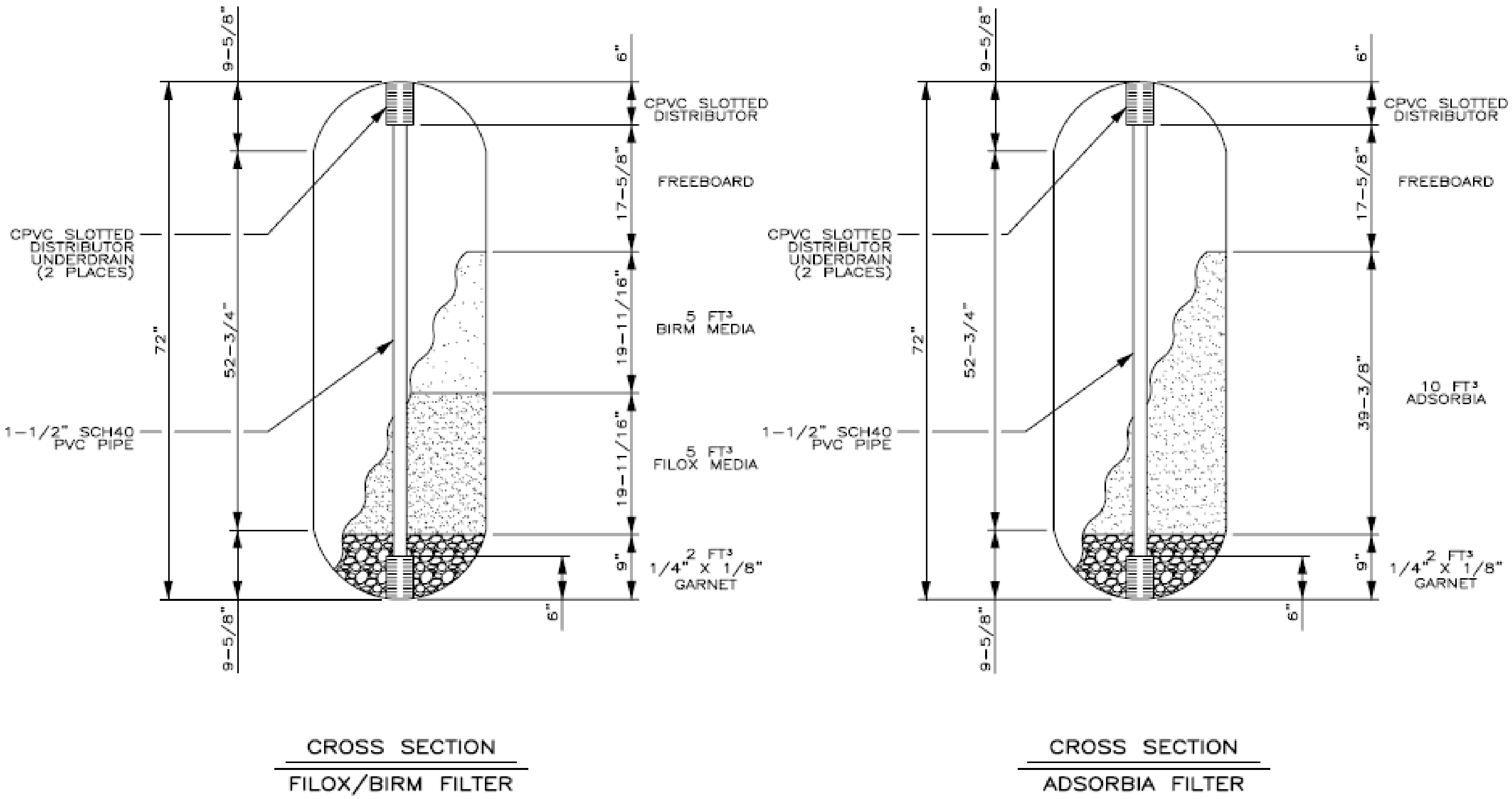


Figure 4-5. Cross Sections of Pre-Oxidation and Adsorptive Media Vessels (As Built)

Table 4-5. Design Features of Arsenic Removal System at HSMHP

Design Parameter	Value	Remarks
Pretreatment		
No. of Vessels	2	–
Configuration	Parallel	–
Vessel Size (in)	24 D × 72 H	3.14 ft^2 cross sectional area
Depth of Birm® Media (in)	19	–
Quantity of Birm® Media (ft^3)	5	Per vessel (10 ft^3 total)
Birm® Design Filtration Rate (gpm/ft^2)	4.8	3.0–5.0 gpm/ft^2 recommended
Depth of Filox™ Media (in)	19	–
Quantity of Filox™ Media (ft^3)	5	Per vessel (10 ft^3 total)
Filox™ Design Filtration Rate (gpm/ft^2)	4.8	5.0 gpm/ft^2 recommended
Clean Bed Pressure Drop (psi)	4	–
Maximum Pressure Drop (psi)	14	–
Underbedding	Garnet	¼-in × ⅛-in, 2 ft^3
Maximum Freeboard (in)	30	–
Backwash Rate (gpm/ft^2)	15	Recommend: 10–12 (Birm®); 25–30 (Filox™)
Bed Expansion for Birm®/Filox™ (%)	>40/<10	Estimate
Backwash Flowrate (gpm)	47	–
Backwash Duration (min)	8	–
Backwash Wastewater Generated (gal/vessel)	376	–
Design Backwash Frequency (time/day)	1	Required by manufacturer
Adsorption		
No. of Vessels	1	–
Vessel Size (in)	24 D × 72 H	–
Vessel Cross Sectional Area (ft^2)	3.14	–
Type of Media	Adsorbsia™ GTO™	–
Quantity of Media (ft^3)	~10	–
Media Bed Depth (in)	38	–
Design Flowrate (gpm)	30	–
Design Hydraulic Loading Rate (gpm/ft^2)	9.5	–
EBCT (min)	2.5	–
Clean Bed Pressure Drop (psi)	8	–
Maximum Pressure Drop (psi)	18	–
Underbedding	Garnet	¼-in × ⅛-in, 2 ft^3
Maximum Freeboard (in)	28	74% of bed expansion
Backwash Rate (gpm/ft^2)	9	6–10 gpm/ft2 recommended
Bed Expansion (%)	50	Estimated
Backwash Flowrate (gpm)	27	–
Backwash Duration (min)	8	–
Backwash Wastewater Generated (gal/vessel)	216	–
Design Backwash Frequency	As needed	
Filtration System		
Average Throughput to System (gal/day)	10,800	Estimated based on 6 hr/day, 30 gpm flowrate
Daily Throughput (BV/day)	144	1 BV = 10 ft^3 = 74.8 gal
Estimated Media Life (month)	38	168,000 BV (with pretreatment)

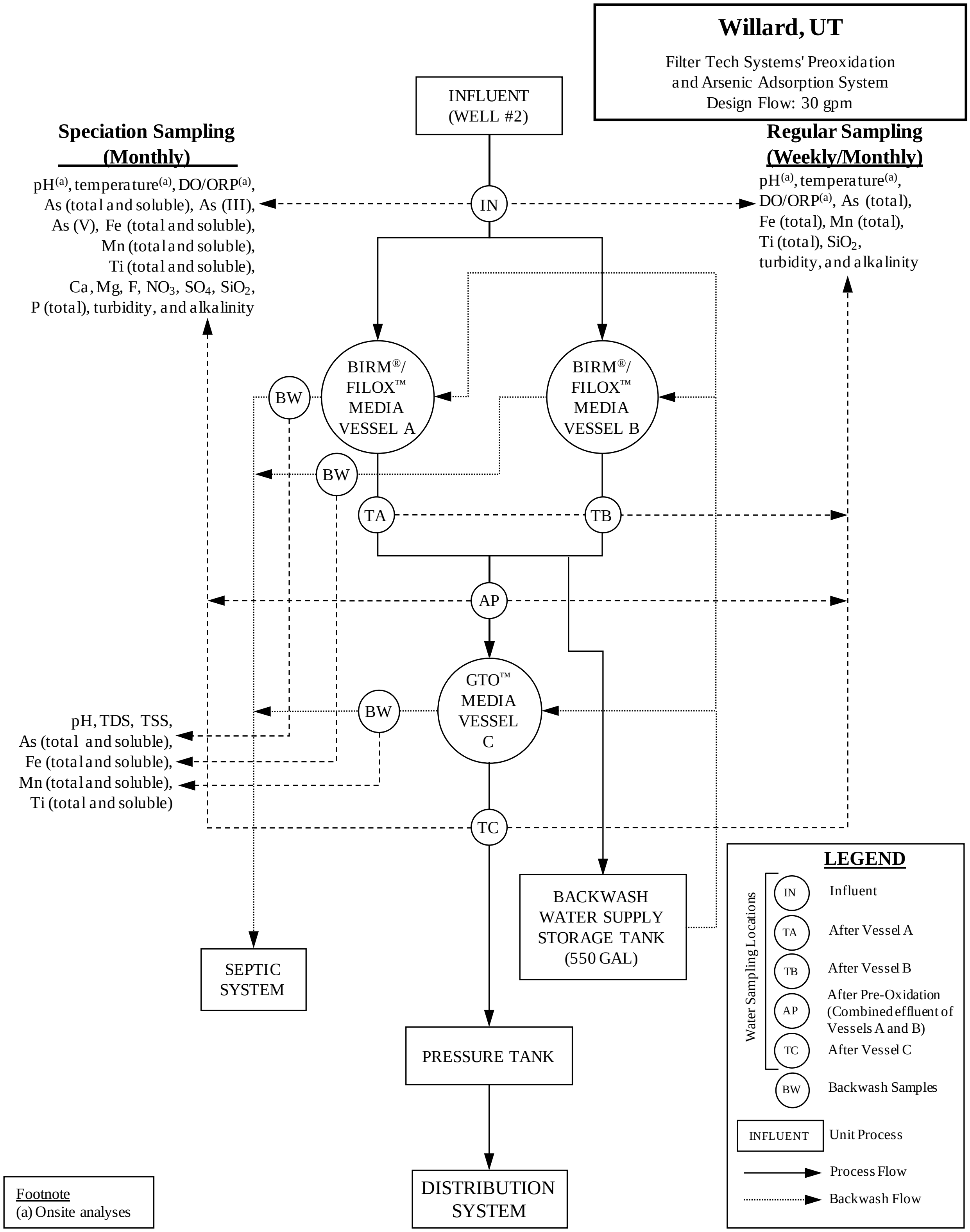


Figure 4-6. Process Flow Diagram and Sampling Locations

Figure 4-7. Composite Fiberglass Vessels (top) and Associated Piping (bottom)

Figure 4-8. PLC Panel

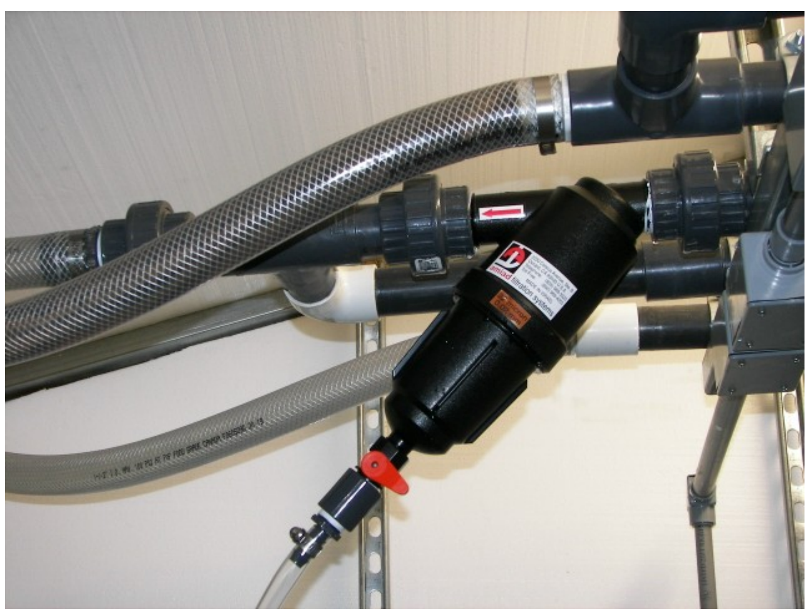


Figure 4-9. Strainer Installed Before Adsorption Vessel

Figure 4-10. 550-gal Backwash Supply Tank

completion of pre-oxidation vessel backwash and return of the freshly backwashed vessels to service (to fill the 550-gal backwash supply tank first [see discussion in Section 4.3.3]). By design, each pre-oxidation vessel was to be backwashed daily at 47 gpm for 8 min, producing 376 gal of wastewater per vessel.

The AM vessel was backwashed as needed. Once initiated, the vessel was backwashed at 27 gpm for 8 min, producing 216 gal of wastewater. The wastewater produced was discharged to a septic system behind the treatment building (Figure 4-11). No permit was needed to discharge the backwash wastewater to the septic system.

- **Media Replacement**. When arsenic concentrations in Adsorbsia™ GTO™-treated water approaches 10 μg/L, replacement of the media will be necessary. Based on the estimate provided by the vendor, breakthrough of arsenic at 10 μg/L would be expected after treating approximately 168,000 BV of water. The spent media can be disposed of as non-hazardous waste in a sanitary landfill if it passes the EPA's TCLP. During the performance evaluation study, neither the media in the pre-oxidation nor the adsorption vessel required a changeout.

Figure 4-11. Backwash Discharge Point Behind Treatment Building

4.3 System Installation

4.3.1 Permitting. For the permit application, Filter Tech prepared an engineering package, including design drawings and a process description of the proposed treatment system. After it was reviewed and signed by a Utah-licensed professional engineer (Hansen, Allen & Luce, Inc.), the package was submitted to and approved by Utah DDW on July 7 and August 7, 2008, respectively.

Following installation of the treatment system, Hansen, Allen & Luce, Inc. submitted an operating permit request (that included final as-built drawings and bacteria test results) to Utah DDW. Utah DDW issued on December 11, 2008, a temporary permit, which stipulated a monitoring and a quarterly reporting requirement and remained effective through December 31, 2009. As opposed to a permanent permit, the temporary permit was issue because Utah DDW needed to evaluate the data to be generated during the EPA demonstration study and determine an appropriate monitoring schedule. The operator obtained a permanent permit before the temporary permit had expired.

4.3.2 Building Preparation. To house the new treatment system, a 10-ft × 10-ft × 8-ft prefabricated metal structure with a 6 ft × 6 ft roll-up door (Figure 4-12) was installed on a concrete pad poured in late August 2008. The building installation began on September 6, 2008, and was completed on September 11, 2008.

4.3.3 Installation, Shakedown, and Startup. Installation of the treatment system began on September 16, 2008. Installation activities included offloading, placing, and connecting the pre-oxidation/adsorption vessels to influent, effluent and backwash tie-in points, and completing electrical wiring for system controls. Several trips were required to complete the installation due to an inaccurate estimate of the building height. The original system piping was pre-fabricated based on a ceiling/wall height of 8 ft. Although the ceiling height was 8 ft, the walls were several feet shorter, resulting in insufficient clearance over the vessels for the rigid, pre-fabricated piping to fit in. Therefore, flexible tubing had to be used, instead, for vessel inlet and outlet connections (Figure 4-13). The pre-

Figure 4-12. New Treatment Building

Figure 4-13. Treatment System Installed

oxidation/adsorption vessels and a backwash pump were bolted to the floor with concrete anchors and pipe supports mounted to ceiling joints.

Media Loading. A slotted polyvinyl chloride (PVC) underdrain was installed in the bottom of each vessel with a 1½-in Schedule 40 standpipe. Two ft^3 of garnet (¼-in × ⅛-in), 5 ft^3 of Filox™, and 5 ft^3 of Birm® were then loaded sequentially through a 4-in opening at the top of each pre-oxidation vessel. The amount of garnet was enough to cover the underdrain. The depth of each media layer was measured at approximately 19.7 in, close to the calculated value of 19.1 in based on the media volume and vessel diameter.

On October 4, 2008, 2 ft^3 of garnet and 10 ft^3 of Adsorbsia™ GTO™ were loaded into the adsorption vessel. The media depth was measured at approximately 39.4 in, close to the calculated value of 38.2 in based on the media volume and vessel diameter. Freeboard was measured from the top of the vessel to the top of the media layer to ensure sufficient room for backwashing. The freeboard measured was 20 in in the pre-oxidation vessels and 21 in in the adsorption vessel. Although smaller than the design values of 30 and 28 in, respectively (see Table 4-5), these freeboards provided more than 50% of bed expansion, sufficient to meet media backwashing needs.

Media Backwashing. To prepare for media backwashing, the 550-gal backwash supply tank was first filled with well water via piping that bypassed the treatment system (see Figure 4-14). Because the well water contained a large amount of silt, a layer of sediment was found to deposit at the bottom of the tank. Therefore, the piping to the tank had to be disconnected and the tank was rinsed out. The tank was then refilled to approximately 460 gal.

Figure 4-14. Backwash Supply Tank and Inlet Piping

The pre-oxidation vessels were backwashed manually one at a time. Backwash flowrates were controlled by throttling a 2-in PVC ball valve on the backwash line. The initial flowrate to a vessel was 8.5 gpm, which was maintained until the vessel was completely filled. Afterwards, the flowrate was incrementally increased to 20, 38, and 47 gpm (or 6.4, 12.1, and 15.0 gpm/ft^2). The flowrate was then kept steady at 47 gpm until the backwash supply tank was almost empty. The amount of water in the backwash supply tank (460 gal) was enough to allow for a complete backwash cycle at the design flowrate of 47 gpm and the design duration of 8 min.

Each pre-oxidation vessel was backwashed five times over a two-day period on October 22 and 23, 2008. Although the backwash effluent was never completely cleared up after the five backwashes (Figure 4-15), the vessel effluent looked clear, indicating a clean bed. The total amount of water used for backwash was 5,206 gal. The freeboard measured in both vessels after the fifth backwash was 21 in, indicating the loss of approximately 1 in of media during backwash. The new bed depth was 18.7 in.

Figure 4-15. Wastewater Collected After First (left) and Fifth Backwashes (right)

To prepare Adsorbsia™ GTO™ media for backwashing, the backwash supply tank was cleaned and refilled with 430 gal of treated water from the newly backwashed pre-oxidation vessels. The 430 gal of water in the backwash supply tank would last for 16 min (or twice the design duration) if the backwash flowrate was maintained at the design flowrate of 27 gpm.

The Adsorbsia™ GTO™ startup procedure called for backwashing the media with 75 to 90 BV (5,610 to 6,732 gal) of water at 6 to 10 gpm/ft^2 (or 18.9 to 31.4 gpm). After filling the vessel at 6 gpm (or 2 gpm/ft^2), the backwash flowrate was set at 14.5 gpm to determine if this flowrate would result in media loss. During the first backwash (with approximately 430 gal of water), some media loss was observed; the backwash flowrate was therefore reduced to 10 gpm. After three and six backwash cycles (each with approximately 430 gal of water), the flowrate was increased to 19 and 27.5 gpm (or 6.1 and 8.8 gpm/ft^2), respectively. Upon completion of the twelfth backwash, backwash wastewater had gone from milky (after the initial backwash) to cloudy (Figure 4-16) and a total of 5,558 gal (or 74.3 BV) of water had been used for backwash. The vessels were backwashed one more time in preparation of disinfection. At this point, a total of 12,233 gal of water had been used to backwash all three vessels.

Because the freeboard in the adsorption vessel was not re-measured after backwash, the pre-backwash bed depth of 39.4 in was used to calculate BV, which was 10.3 ft^3 or 77.1 gal. This bed depth also was shown in the as-built cross section drawing in Figure 4-5.

Vessel Disinfection. The two pre-oxidation and one adsorption vessels were disinfected using a 185 mg/L (as Cl_2) sodium hypochlorite (NaOCl) solution, prepared by adding 1.4 gal of Clorox® bleach (containing 6% NaOCl) into 500 gal of treated water in the backwash supply tank. After 140 gal of the

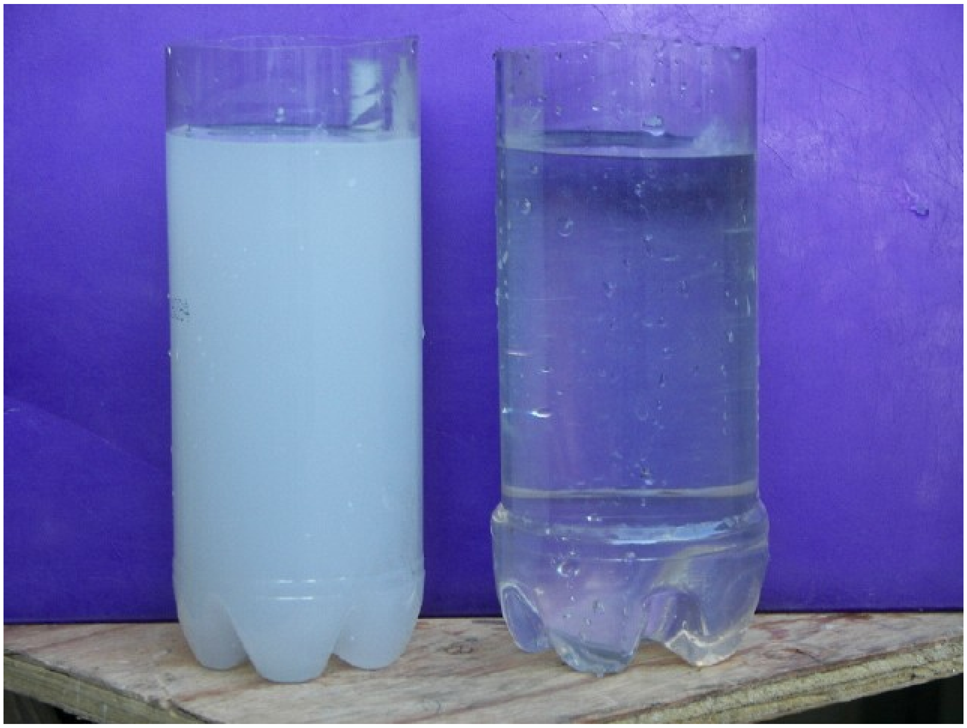


Figure 4-16. Appearance of Backwash Wastewater After First (left) and Twelfth Backwashes (right)

chlorine solution was pumped upflow through each vessel at 6 gpm, the vessels were allowed to sit overnight. Because the effluent from each vessel contained only a trace level of chlorine residuals, the disinfection procedure was repeated. Upon applying additional 100 gal of the chlorine solution through each vessel, greater than 20 mg/L (as Cl_2) of chlorine residuals were measured in the vessel effluent. The vessels were then rinsed with well water in the service mode (i.e., parallel through the pre-oxidation vessels and then the adsorption vessel) until chlorine residuals in the vessel effluent were below its MDL. A sample was collected downstream of the Adsorbsia™ GTO™ vessel for the Bac-T test.

Startup Issues. Soon after system startup on December 11, 2008, it was noted that when the system pressure became low, the normally closed, hydraulically-operated diaphragm valves on the backwash line would open (due to lack of pressure on the diaphragm to close the valves), causing water to constantly leak and bypass the treatment system. To alleviate this concern, a small bladder tank was installed on the treated water line and filled with pressurized water from the distribution system and a check valve was installed to keep the tank pressurized if there was a loss of pressure in the system. Meanwhile, the hydraulic line supplying the diaphragm valves was taken after the check valve but before the tank so that there was always enough pressure in the bladder tank to open and close the diaphragm valves. During normal operation, the bladder tank was kept at the same pressure as the system. However, when the well pump went into sleep mode or if the system lost pressure, the bladder tank would maintain the normal system pressure and keep the diaphragm valves closed.

In addition, the backwash supply tank refill line was separated from the service line so that it would not cause the variable frequency drive (VFD) pump to run at a higher flowrate during refill of the backwash supply tank. This modification reduced the well pump flowrate from approximately 30 to 20 gpm during refill of the backwash supply tank.

Issues Observed During Battelle's Site Visit. On January 21, 2009, two Battelle staff members visited the site to inspect the system and provide operator training on the data and sample collection. When onsite, the system was backwashed for observation and residual sampling. Table 4-6 summarizes PLC settings and measurements taken during backwash. Table 4-7 presents flowrates measured during refill of the backwash supply tank. The time delay between Vessels A and B backwashing was initially set at 2,150 sec (~36 min) for the backwash supply tank to be refilled. Since it took only 1,660 sec (~27 min) to refill the tank, the time delay was shortened to 1,800 sec (30 min). The 27 min refill time was based on a refill flowrate of 13 gpm. Based on the data presented in Table 4-7, refill flowrates could be as high as 17.2 gpm. Therefore, the refill time could be as short as 21 min.

Table 4-6. Backwash Settings and Measurements

Setting	Control Mechanism	Value
Backwash Duration	PLC Setting	8 min
Backwash Frequency	PLC Setting	Weekly (Fridays, 13:00)
Backwash Flowrate	Valve Control (Manually adjusted)	~45–48 gpm
Backwash Tank High Mark	High Float Switch (Pump on)	~470 gal
Backwash Tank Low Mark	Low Float Switch (Pump off)	~110 gal
Backwash Volume for TA	PLC Setting/Float Switches/Valve	374 gal
Backwash Volume for TB	PLC Setting/Float Switches/Valve	383 gal
Refill Rate to Backwash Tank	Valve Control (Manually adjusted)	~13 gpm
Actual Time Taken to Refill	None (Timed during backwash)	1,660 sec (~27 min)
Current Delay Setting	PLC Setting	2,150 sec (~36 min)
New Delay Setting	PLC Setting	1,800 sec (30 min)

Table 4-7. Flowrates Measured During Refill of Backwash Supply Tank

Time	"IN" Flowrate	TA Flowrate (= IN-TB)	TB Flowrate	TC Flowrate	Refill Rate (= IN-TC)
NA	19 gpm	11 gpm	8 gpm	4.8 gpm	14.2 gpm
17:55	23.6 gpm	15.2 gpm	8.4 gpm	6.4 gpm	17.2 gpm

Samples of backwash wastewater were collected at the backwash discharge point at the beginning, during, and the end of pre-oxidizing media backwashing. These samples were collected for visual observation of water quality and signs of media loss. As shown in Figure 4-17, all three samples looked cloudy but contained little media. This suggests that the media needed to be backwashed more frequently than weekly and that bed expansion during backwash was within the available freeboard height. Water samples collected at the AP sampling location during refill of the backwash supply tank also were cloudy and contained a small amount of media (see photographs in Figure 4-18 for a water sample taken at AP versus a water sample taken at IN). This indicates that the pre-oxidizing media had not been thoroughly cleaned during backwashing and that the media was not given enough time to settle prior to being put back into service to refill the backwash supply tank.

Based on the above-mentioned and other observations made during the site visit, a punch list was developed and discussed with Filter Tech. Punch-list items included the following:

- Install a sediment filter prior to the inlet flow totalizer

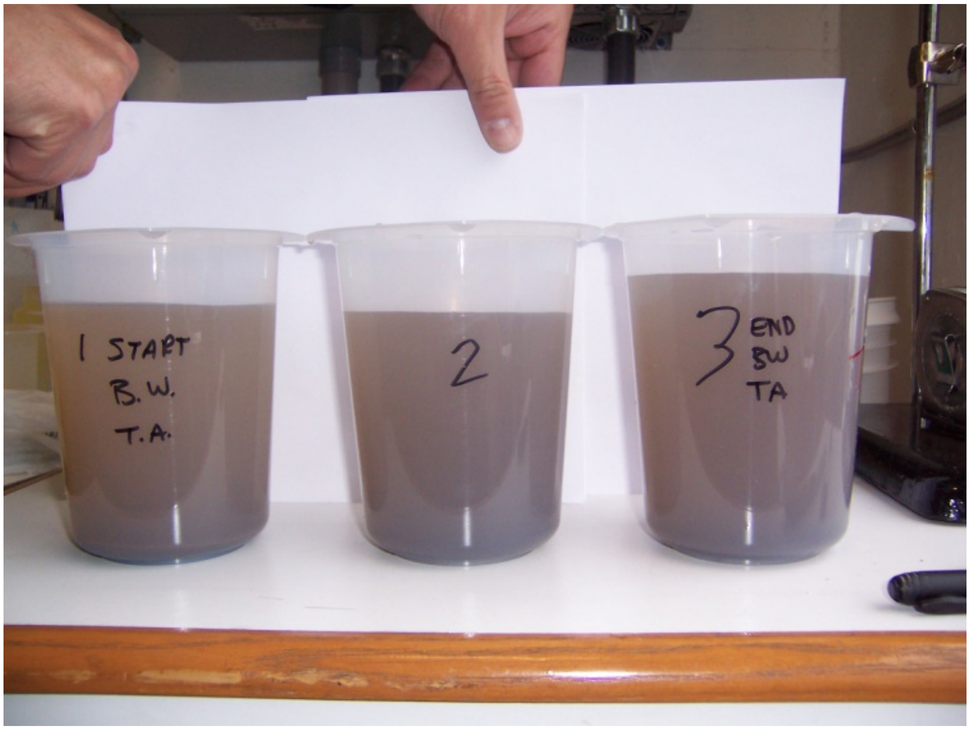


Figure 4-17. Backwash Wastewater Samples Collected at Beginning, Middle, and End of a Backwash Cycle

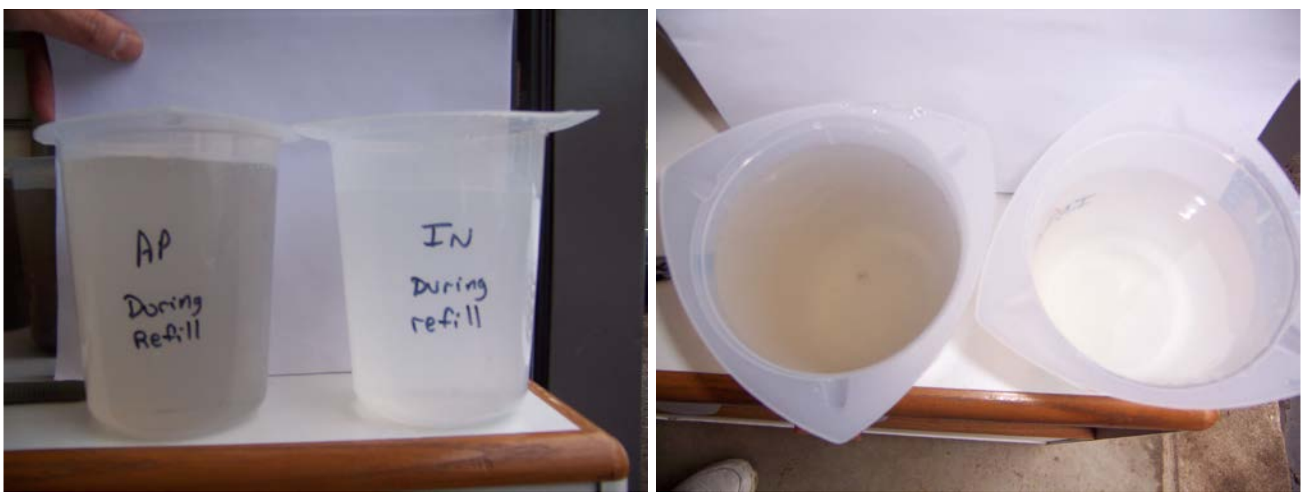


Figure 4-18. Comparison of IN (right) and AP (left) Samples Collected During Refill of Backwash Supply Tank

- Install a high pressure cut-off switch for the well pump
- Replace all pressure gauges with more accurate gauges
- Install a flow totalizer for Tank A
- Establish a delay after each filter has been backwashed to allow media to settle before putting back into service to refill the backwash supply tank

- Set timer to backwash daily
- Supply a revised schematic that reflects all system modifications that have been made
- Install a new backwash sample tap
- Develop a plan for backwashing Tank C.

Filter Tech ordered materials and parts and returned to the site on April 18 to 19, 2009 to complete all punch-list items mentioned above. While onsite, a separate backwash supply line to Tank C was installed to allow backwashing of Tank C. Tank C was backwashed; the backwash discharge showed no sediment buildup.

4.4 System Operation

4.4.1 Operational Parameters. The operational parameters for the demonstration study were tabulated and are attached as Appendix A. Table 4-8 summarizes key parameters. The performance evaluation study began on December 11, 2008, and ended on October 18, 2010. During the study period, the well pump operated for a total of 15,835 hr, averaging 23.4 hr/day (for 676 days). The well pump ran almost around the clock, occasionally going into a sleep mode.

As noted in Section 4.2, flowrates and volume throughputs were tracked by five Signet insertion turbine flow meters/totalizers located separately at the system inlet, after Vessels A, B, and C, and on the backwash water supply line. The inlet flow meter/totalizer stopped registering incoming flow on March 30, 2010, rendering it useless for tracking the system flow. The flow meter/totalizer on Vessel A was not installed until April 9, 2009; therefore, the flow through Vessel A prior to this date was estimated by subtracting the flow through Vessel B from the flow through Vessel C. Although not done, this amount should have been further adjusted by adding half of the flow used to refill the backwash supply tank prior to April 9, 2009.

In theory, the inlet flow should be equal to the sum of the flow through Vessels A and B and equal to the sum of the flow through Vessel C and the flow to refill the backwash supply tank. Based on the meters/totalizers installed on the three vessels, the total amount of water treated by the two pre-oxidation vessels was 5,198,000 gal (including 2,571,000 and 2,627,000 gal through Vessels A and B, respectively); the total amount of water treated by the adsorption vessel (Vessel C) was 5,629,000 gal. Instead of being lower, this amount (5,629,000 gal) was actually higher than the total flow through both pre-oxidation vessels. While it was not clear what had caused this to occur, the way the flow meters/totalizers were installed (i.e., flexible hoses with short straight length) could contribute, in part, to the discrepancies observed. As specified by the meter manufacturer, depending on the piping configurations, the straight length upstream from the flow sensor should be 10 to 50 times (15 to 75 in) the inner diameter of the pipe and the straight length downstream from the flow sensor should be at least five times (7.5 in) the inner diameter of the pipe. With all piping/valves/meters/gauges installed in a rather congested area as shown in Figure 4-7, these requirements most likely were not met. The other possible cause was the ability of the flow meters/totalizers to register flow with <4 gpm flowrates. This is discussed in detail in Section 4.4.3.

Based on the Vessel C flow meter/totalizer, the system treated 5,629,000 gal (or 73,000 BV) of water (bed volumes were calculated based on 10.3 ft^3 [or 77.1 gal] of media). Daily demands through the entire study period ranged from 2,476 to 21,987 gal and averaged 8,354 gal, which was 24% lower than the 11,000 gpd provided by the operator prior to the demonstration study.

Table 4-8. Summary of System Operation

Operational Parameter	Value/Condition			
Operating Period	12/11/08–10/18/10			
Total Operating Time (day)	676			
Well Pump				
Total Operating Time (hr)	15,835			
Average Daily Run Time (hr/day)	23.4			
Birm®/Filox™ Pre-Oxidation				
Throughput (gal)	Vessel A	Vessel B	Combined	
	2,571,000[(a)]	2,627,000	5,198,000	
Instantaneous Flowrate (gpm)	Vessel A	Vessel B	Combined	
	4.5 [0.6–13.8]	4.6 [0.6–20.9]	9.3 [1.2–27.1]	
Hydraulic Loading (gpm/ft^2)	Vessel A	Vessel B		
	1.4 [0.2–4.4]	1.5 [0.2–6.7]		
Vessel/System Pressure and Δp (psi)	Vessel	Inlet	Outlet	Δp
	A	61 [50–92]	59 [48–94]	2 [0–14]
	B	61 [50–92]	59 [40–98]	2 [0–20]
Adsorbsia™ Adsorption System				
Throughput (gal)	5,629,000			
Daily Demand (gal/day)	8,354 [2,476–21,987]			
Bed Volume (BV)	73,010[(b)]			
Instantaneous Flowrate (gpm)	7.3 [0.7–24.0]			
EBCT (min)	10.6 [3.2-110]			
Vessel/System Pressure and Δp (psi)	Vessel	Inlet	Outlet	Δp
	C	60 [40–76]	54 [45–62]	6 [0–22]
Birm®/Filox™ Backwash Operation				
Backwash Frequency	Daily			
Backwash Flowrate (gpm)	47			
Number of Backwash Cycles	676			
Duration (min)	8			
Backwash Volume (gal/cycle)	776			
Total Wastewater Produced (gal)	511,800			
Wastewater Production Rate	10%			

(a) Vessel A totalizer installed on April 9, 2009; throughput prior to April 9, 2008, calculated based on Vessels B and C totalizer readings.
(b) Calculated based on 10.3 ft^3 (or 77.1 gal) of media in vessel.

Instantaneous flowrates through Vessels A and B (as read from the respective Signet flow meters) fluctuated extensively from 0.6 to 20.9 gpm. Instantaneous flowrates through Vessel C also fluctuated extensively from 0.7 to 24 gpm. The higher flowrates occurred when the backwash supply tank was being filled, either from the combined effluent of Vessels A and B or from the effluent of Vessel C. The fill rate to the backwash supply tank was controlled by a PVC ball valve and could be manually adjusted. The fill rate was set to be less than the system maximum flowrate because pumping at a high flowrate over an extended period could cause an increase in the sediment content in well water.

The average flowrate through the two pre-oxidation vessels was 9.3 gpm; the average flowrate through the adsorption vessel was 7.3 gpm. These flowrates were much lower than the 30-gpm design value as shown in Table 4-5. At these average flowrates, hydraulic loading rates were 1.4 and 2.3 gpm/ft^2, respectively (compared to the design values of 4.8 and 9.5 gpm/ft^2, respectively). EBCTs with the AM ranged from 3.2 to 110 min and averaged 10.6 min, which was four times the vendor-recommended EBCT of 2.5 min.

System inlet pressure readings ranged from 50 to 92 psi averaging 61 psi. Pre-oxidation outlet pressure readings ranged from 40 to 98 psi, averaging 59 psi. Differential pressure (Δp) across the pre-oxidation vessels ranged from 0 to 20 psi and averaged 2 psi. These Δp readings reflect results of a daily backwash schedule. Δp across the adsorption vessel ranged from 0 to 22 psi and averaged 6 psi. These Δp readings reflect results of one backwash on April 18, 2009 throughout the study period.

From December 11, 2008, through October 18, 2010, 511,800 gal of backwash wastewater was produced. Assuming that daily backwash began on December 11, 2008, 676 backwashes would have been done by the end of the study period. Therefore, each backwash would have produced 776 gal of wastewater, which is very close to the design value of 752 gal for both vessels (at 47 gpm for 8 min per vessel).

4.4.2 Residual Management. Residuals generated by the operation of the system included only backwash wastewater. Neither the oxidation media (Birm®/Filox™) nor the AM (Adsorbsia™ GTO™) were replaced during the study period. The wastewater produced was discharged to the septic tank behind the treatment building (Figure 4-11). No permit was necessary to discharge the backwash wastewater to the septic system.

4.4.3 System/Operation Reliability and Simplicity. There were no major operational issues affecting the system; only minor repairs were made to the system. Filter Tech made a site visit on June 13, 2009, to calibrate all flow meters/totalizers. The issue was that the new flow totalizer on Vessel A would not register flow when its flowrate was lower than 4 gpm. This was unlike the flow meters/totalizers on both Vessel B and the backwash water supply line that were capable of registering flow down to 3 gpm due to the use of a more sensitive sensor. Filter Tech switched the flow meter/totalizer on Vessel A with one on the backwash water supply line so that both Vessels A and B had identical flow meters/totalizers. On August 25, 2009, and June 22, 2010, the operator took the system offline to replace a leaking nut on the piping leading to Vessel B. The system was offline for several days until the repair work was complete.

The system O&M and operator skill requirements are discussed below in relation to pre- and post-treatment requirements, levels of system automation, operator skill requirements, preventive maintenance activities, and frequency of chemical/media handling and inventory requirements.

Pre- and Post-Treatment Requirements. Pretreatment included oxidation/filtration with Birm®/Filox™ media for iron and manganese removal and soluble As(III) oxidation. Iron and manganese particles formed were backwashed out of media beds. There was no post chlorination of the distribution water.

System Automation. The Birm®/Filox™ and Adsorbsia™ GTO™ system included automated controls for service and backwash operations.

Operator Skill Requirements. Under normal operating conditions, the skills required to operate the arsenic treatment system were minimal. The operator’s duties were to monitor the pre-oxidation and adsorption vessels, and initiate manual backwash when necessary.

Utah's Operator Certification Program is authorized by Section R309-105-11 of the Utah Public Drinking Water Rules. The rules state that "all community and non-transient non-community water systems or any public system that employs treatment techniques for surface water or ground water under the direct influence of surface water shall have an appropriately certified operator.” The specific requirements are located in Section 309-300, Certification Rules for Water Supply Operators.

All public drinking water systems within the state of Utah are assigned a complexity level (I, II, III, IV) and discipline (Treatment or Distribution) for the certification requirements of their operators. Any operator who makes independent decisions that affect the sanitary quality, safety, and adequacy of the water to their system needs to be certified to the grade of the system. HSMHP was classified as a "distribution" facility and designated as a "small system" serving a population between 25 and 500 persons. Operators running a "small system" are required to obtain 2.0 continuing education units within a three-year period to renew certification.

Preventive Maintenance Activities. Preventive maintenance tasks included such items as periodic checks of flow meters and pressure gauges and inspection of system piping and valves. Typically, the operator performed these duties only when he was onsite for routine activities. The operator recorded flow, volume, and pressure readings of the system daily.

Chemical/Media Handling and Inventory Requirements. No chemical was used as part of the treatment system at the HSMHP.

4.5 System Performance

The performance of the HSMHP arsenic removal system was evaluated based on analyses of water samples collected from the treatment plant, the media backwash residuals, and distribution system.

4.5.1 Treatment Plant Sampling. Water samples were collected on 64 occasions, including three duplicate events, with field speciation performed on 22 occasions at the IN, AP, and TC sampling locations. TA and TB also were sampled seven times between December 17, 2008, and February 18, 2009, and on March 10, 2009, and then discontinued thereafter. Sample location AP was not sampled on March 10, 2009.

Table 4-9 presents a statistical summary of key analytical results of arsenic species, total and soluble iron, and manganese measured at the IN, AP, and TC sampling locations across the treatment train. Table 4-10 summarizes the statistical summary of other water quality parameters at the same three locations. The analytical data at TA and TB were not used for the statistical analysis due to small sample sizes (i.e., 3 to 7). Appendix B contains a complete set of analytical results for the demonstration study. The results of the treatment plant sampling are discussed below.

Arsenic. The key parameter for evaluating the treatment effectiveness was the arsenic concentration in treated water. Figure 4-19 contains three bar charts showing concentrations of arsenic species, including particulate arsenic, soluble As(III), and soluble As(V) at the IN, AP, and TC locations for each of the 22 speciation events. Total arsenic concentrations in source water ranged from 9.4 to 21.1 µg/L and averaged 13.2 µg/L (Table 4-9). Of the soluble fraction, As(III) and As(V) each accounted for about half of the concentration at 6.0 and 5.8 µg/L, respectively (on average). Except for one spike of 8.8 µg/L on September 23, 2009, particulate arsenic concentrations were low, averaging 1.3 µg/L.

After the Birm®/Filox™ treatment, there was 21% reduction in total arsenic concentration to 10.4 µg/L (on average), indicating removal by Birm®/Filox™. The remaining arsenic existed primarily as soluble As(V) with concentrations ranging from 8.7 to 11.1 µg/L and averaging 10.0 µg/L. Soluble As(III) and particulate arsenic concentrations were low, averaging 0.3 and 0.2 µg/L, respectively (on average). Therefore, the Birm®/Filox™ treatment was effective in oxidizing soluble As(III) to soluble As(V) throughout the study period.

The Adsorbsia™ GTO™ media further removed soluble As(V) to below the 10-µg/L MCL. Figure 4-20 presents total arsenic breakthrough curves from the pre-oxidation and adsorption vessels. By September

Table 4-9. Summary of Arsenic, Iron, and Manganese Analytical Results

Parameters	Sample Location	Unit	Sample Count	Concentration			Standard Deviation
				Minimum	Maximum	Average	
As (total)	IN	μg/L	64	9.4	21.1	13.2	2.4
	AP	μg/L	60	5.4	13.0	10.4	1.2
	TC	μg/L	64	<0.1	7.0	-[(a)]	-[(a)]
As (soluble)	IN	μg/L	22	7.9	15.1	11.8	1.5
	AP	μg/L	21	9.0	11.4	10.3	0.7
	TC	μg/L	22	<0.1	7.2	-[(a)]	-[(a)]
As (particulate)	IN	μg/L	22	0.1	8.8	1.3	1.8
	AP	μg/L	21	<0.1	1.6	0.2	0.4
	TC	μg/L	22	<0.1	1.1	-[(a)]	-[(a)]
As(III)	IN	μg/L	22	2.8	8.3	6.0	1.5
	AP	μg/L	21	<0.1	1.0	0.3	0.2
	TC	μg/L	22	<0.1	2.1	-[(a)]	-[(a)]
As(V)	IN	μg/L	22	3.9	10.0	5.8	1.3
	AP	μg/L	21	8.7	11.1	10.0	0.7
	TC	μg/L	22	<0.1	7.1	-[(a)]	-[(a)]
Fe (total)	IN	μg/L	64	<25	871	276	198
	AP	μg/L	63	<25	62.7	<25	6.3
	TC	μg/L	64	<25	62.1	<25	7.2
Fe (soluble)	IN	μg/L	22	36.9	210	93	42.9
	AP	μg/L	21	<25	59	<25	10.2
	TC	μg/L	22	<25	<25	<25	0.0
Mn (total)	IN	μg/L	64	87.6	286	116	25.7
	AP	μg/L	63	<0.1	45.1	4.0	8.4
	TC	μg/L	64	<0.1	50.1	2.6	8.6
Mn (soluble)	IN	μg/L	22	83.3	130	109	13.0
	AP	μg/L	21	<0.1	0.3	0.1	0.1
	TC	μg/L	22	<0.1	38.8	2.4	8.5

One-half of detection limit used for concentrations less than detection limit for calculations.
Duplicate samples included in calculations.
(a) Statistics not meaningful; see arsenic breakthrough curves at TC location in Figure 4-20.

14, 2010, when the last set of samples was collected, total arsenic concentrations in treated water after Adsorbsia™ GTO™ had reached 6.2 μg/L. The amount of water treated at this point was 69,200 BV.

Iron. Total iron concentrations in raw water ranged from <25 to 871 μg/L and averaged 276 μg/L. The soluble fraction ranged from 37 to 210 μg/L and averaged 93 μg/L. Figure 4-21 presents total iron concentrations at the IN, AP, and TC locations for all 64 sampling events. Figure 4-22 contains three bar charts showing concentrations of particulate and soluble iron at the IN, AP, and TC locations for each of the 22 speciation events. The data indicated that iron was mostly removed to below the MDL of 25 μg/L. Iron solids accumulated in the Birm®/Filox™ bed were removed via daily backwashing, which was able to maintain media performance without any signs of iron leakage or media fouling after close to two years of service.

Manganese. Figure 4-23 presents total manganese concentrations at the IN, AP, and TC locations for all 64 sampling events. Total manganese levels in source water ranged from 87.6 to 286 μg/L and averaged 116 μg/L, which existed almost entirely in the soluble form. Following the oxidation/filtration by Birm®/Filox™, total manganese concentrations were reduced to 4.0 μg/L (on average) with no

Table 4-10. Summary of Other Water Quality Parameter Results

Parameters	Sample Location	Unit	Sample Count	Concentration Minimum	Maximum	Average	Standard Deviation
Alkalinity (as $CaCO_3$)	IN	mg/L	55	135	152	143	4.3
	AP	mg/L	54	129	153	143	4.7
	TC	mg/L	55	135	161	143	5.1
Fluoride	IN	mg/L	22	<0.1	0.1	0.1	0.0
	AP	mg/L	21	<0.1	0.2	0.1	0.0
	TC	mg/L	22	<0.1	0.2	0.1	0.0
Sulfate	IN	mg/L	22	3.2	7.0	6.1	0.7
	AP	mg/L	21	5.7	6.8	6.2	0.3
	TC	mg/L	22	5.7	7.1	6.3	0.4
Nitrate (as N)	IN	mg/L	22	0.1	0.3	0.2	0.0
	AP	mg/L	21	0.1	0.4	0.3	0.1
	TC	mg/L	22	0.2	0.4	0.3	0.0
Total P (as P)	IN	µg/L	22	56.6	170	112	29.0
	AP	µg/L	21	18.7	99.9	67.1	18.5
	TC	µg/L	22	<10	77.6	36.7	27.1
Silica (as SiO_2)	IN	mg/L	55	13.3	17.5	15.4	0.8
	AP	mg/L	54	13.9	17.6	15.4	0.8
	TC	mg/L	55	14.0	18.0	15.5	0.8
Turbidity	IN	NTU	55	0.7	10.0	2.9	2.1
	AP	NTU	54	<0.1	7.4	0.8	1.3
	TC	NTU	55	<0.1	9.9	1.4	1.8
pH	IN	S.U.	50	7.4	8.0	7.6	0.1
	AP	S.U.	49	7.5	8.1	7.7	0.1
	TC	S.U.	49	7.1	8.1	7.8	0.2
Temperature	IN	°C	51	9.0	22.0	17.2	2.8
	AP	°C	51	9.3	21.7	17.4	2.6
	TC	°C	50	9.1	22.3	17.6	2.7
DO	IN	mg/L	49	1.6	5.8	2.4	1.0
	AP	mg/L	49	1.3	4.1	2.0	0.6
	TC	mg/L	48	1.1	5.3	2.1	0.7
ORP	IN	mV	51	112	248	199	26.1
	AP	mV	50	47.1	240	191	28.3
	TC	mV	50	41.2	244	187	28.5
Total Hardness (as $CaCO_3$)	IN	mg/L	22	96.8	129	114	8.3
	AP	mg/L	21	103	126	115	6.8
	TC	mg/L	22	98.0	130	113	8.4
Ca Hardness (as $CaCO_3$)	IN	mg/L	22	73.4	112	93.8	9.1
	AP	mg/L	21	78.0	110	94.5	7.9
	TC	mg/L	22	73.8	113	93.2	9.2
Mg Hardness (as $CaCO_3$)	IN	mg/L	22	16.7	26.6	20.4	2.3
	AP	mg/L	21	16.2	25.4	20.1	2.2
	TC	mg/L	22	16.4	25.5	20.1	2.4
Ti (total)	IN	µg/L	64	1.1	3.3	1.8	0.5
	AP	µg/L	63	0.9	6.1	1.7	0.9
	TC	µg/L	64	0.9	444	16.3	65.9
Ti (soluble)	IN	µg/L	22	0.9	1.9	1.4	0.3
	AP	µg/L	21	0.5	1.9	1.3	0.3
	TC	µg/L	22	0.8	2.6	1.4	0.4

One-half of detection limit used for concentrations less than detection limit for calculations.
Duplicate samples included in calculations.

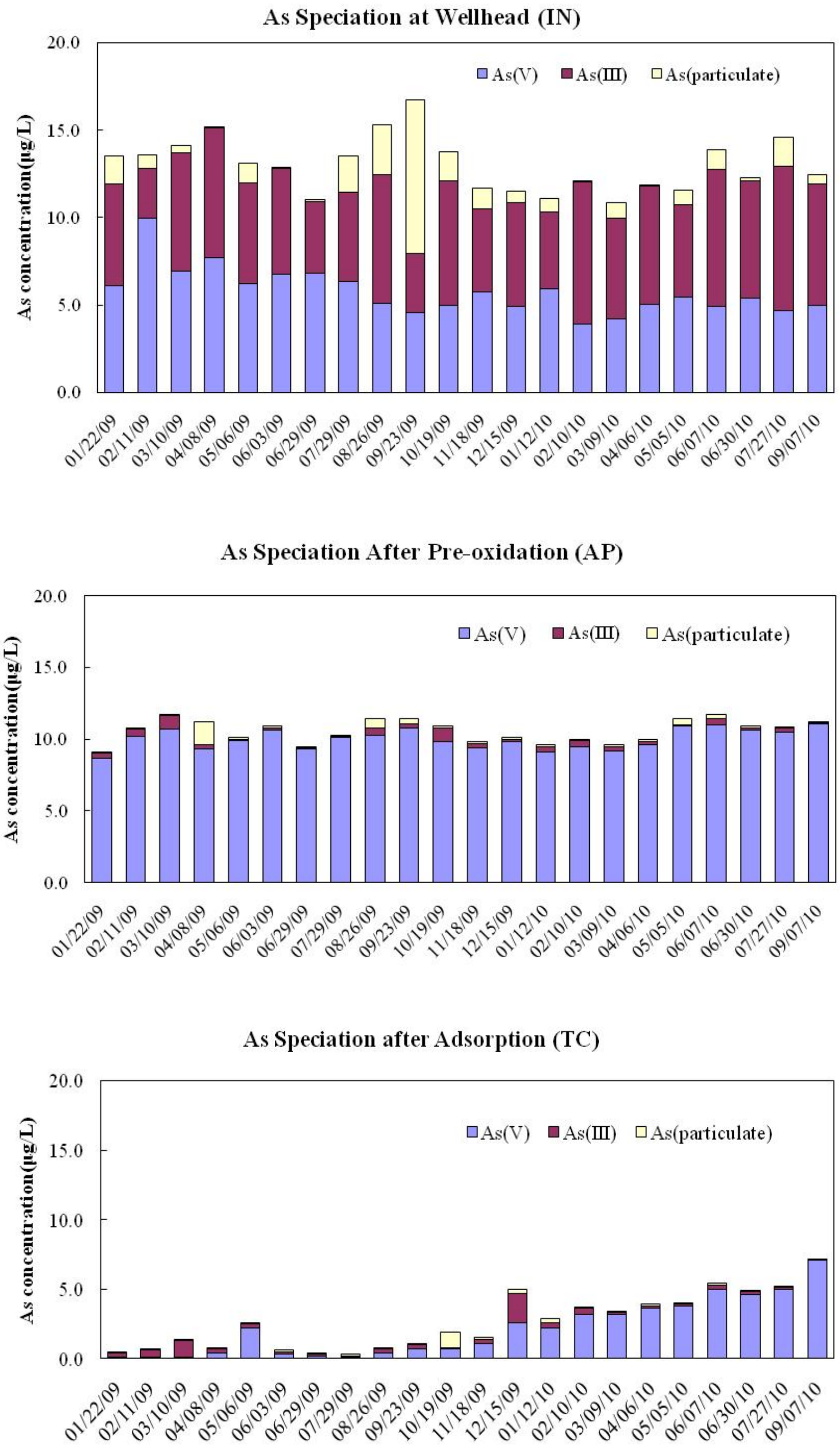


Figure 4-19. Concentrations of Various Arsenic Species at IN, AP, and TC Sampling Locations

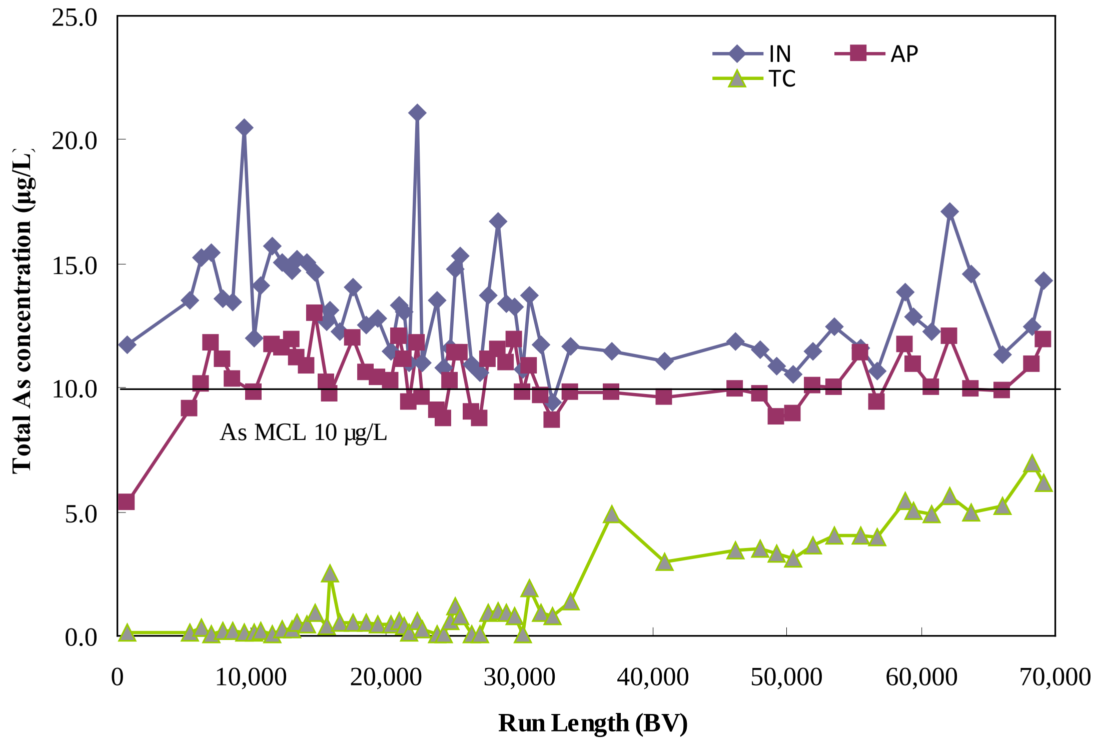


Figure 4-20. Total Arsenic Breakthrough Curves

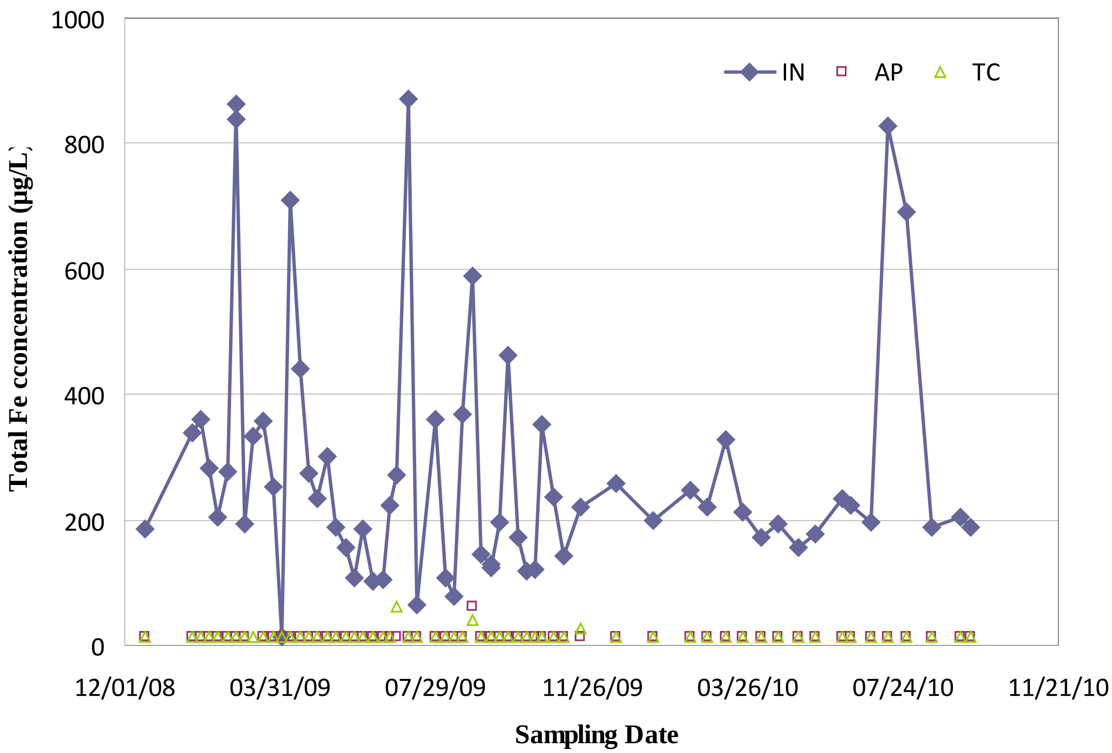


Figure 4-21. Total Iron Concentrations at IN, AP, and TC Sampling Locations

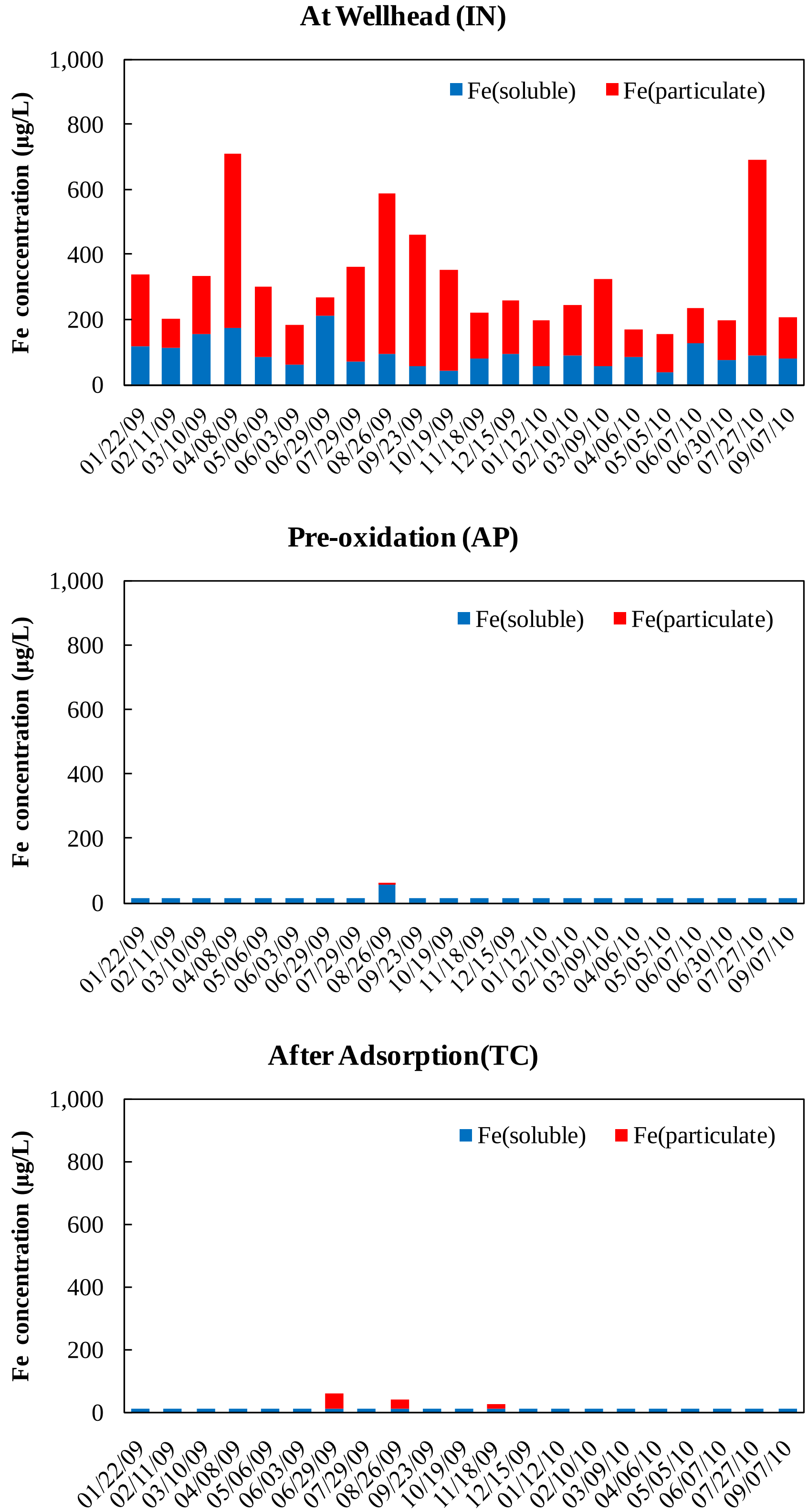


Figure 4-22. Concentrations of Iron Species at IN, AP, and TC Sampling Locations

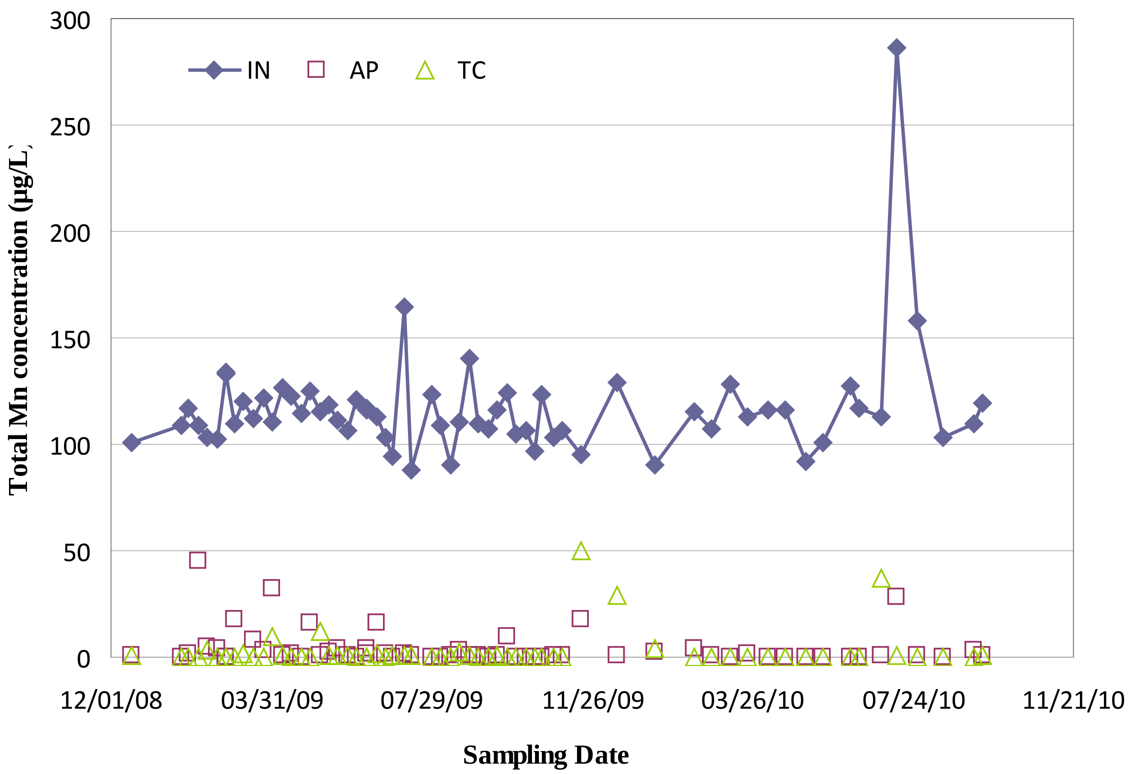


Figure 4-23. Total Manganese Concentrations at IN, AP, and TC Sampling Locations

concentration over the 50-µg/L MCL. The data indicated that Birm®/Filox™ was effective in removing manganese from raw water, preventing the downstream AM from being coated with MnO_2.

Other Water Quality Parameters. Raw water pH values measured at the IN location varied from 7.4 to 8.0. pH values remained essentially unchanged after the dual oxidizing media treatment. Alkalinity also did not vary, with values ranging from 129 to 161 mg/L (as $CaCO_3$) across the treatment train. Treatment plant samples were analyzed for fluoride, sulfate, nitrate, phosphorus, and hardness only when arsenic speciation was performed. Fluoride and nitrate concentrations were low, averaging 0.1 and 0.2 mg/L (as N), respectively, across the treatment train. Sulfate levels also were low, ranging from 3.2 to 7.1 mg/L throughout the treatment train. Concentrations of total hardness, existing primarily as calcium hardness (about 82%), ranged from 97 to 129 mg/L (as $CaCO_3$), and remained essentially unchanged throughout the treatment train. Silica (as SiO_2) concentrations ranged from 13.3 to 18.0 mg/L, and appeared unaffected by the treatment process.

Total phosphorus levels in raw water fluctuated between 57 and 170 µg/L and averaged 112 µg/L. The pre-oxidation step removed 19 to 67% (40% on average) of total phosphorus, leaving 19 to 100 µg/L in the influent to the Adsorbsia™ GTO™ vessel. Adsorbsia™ GTO™ further removed total phosphorus to <10 to 78 µg/L. Figure 4-24 presents total phosphorus breakthrough curves. Figure 4-25 plotted percentages of total phosphorus removal by Birm®/Filox™ and Adsorbsia™ GTO™, respectively. For the first 22,000 BV, Adsorbsia™ GTO™ removed up to 90% of total phosphorus in the vessel influent. However, the removal followed a decreasing trend and was reduced to <20% after approximately 36,000 BV.

Total titanium was monitored throughout the treatment train to evaluate if any Adsorbsia™ GTO™ media had gotten into the treated water in either a soluble or a particulate form. Very little titanium was

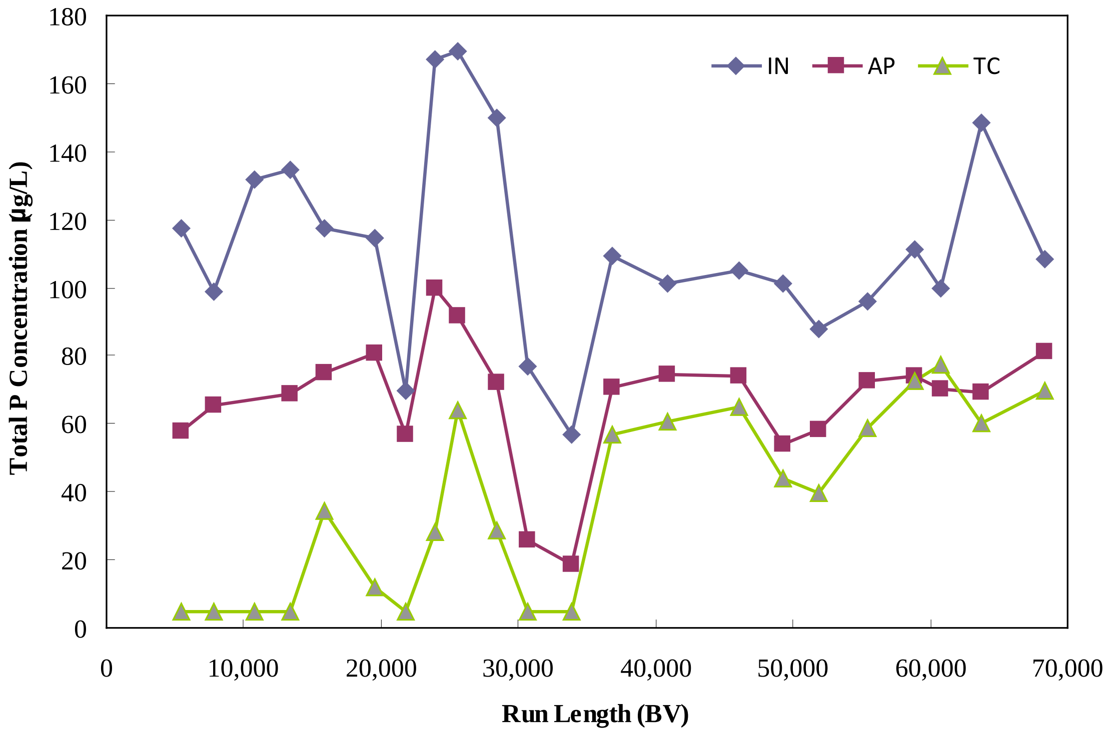


Figure 4-24. Total Phosphorus Breakthrough Curves

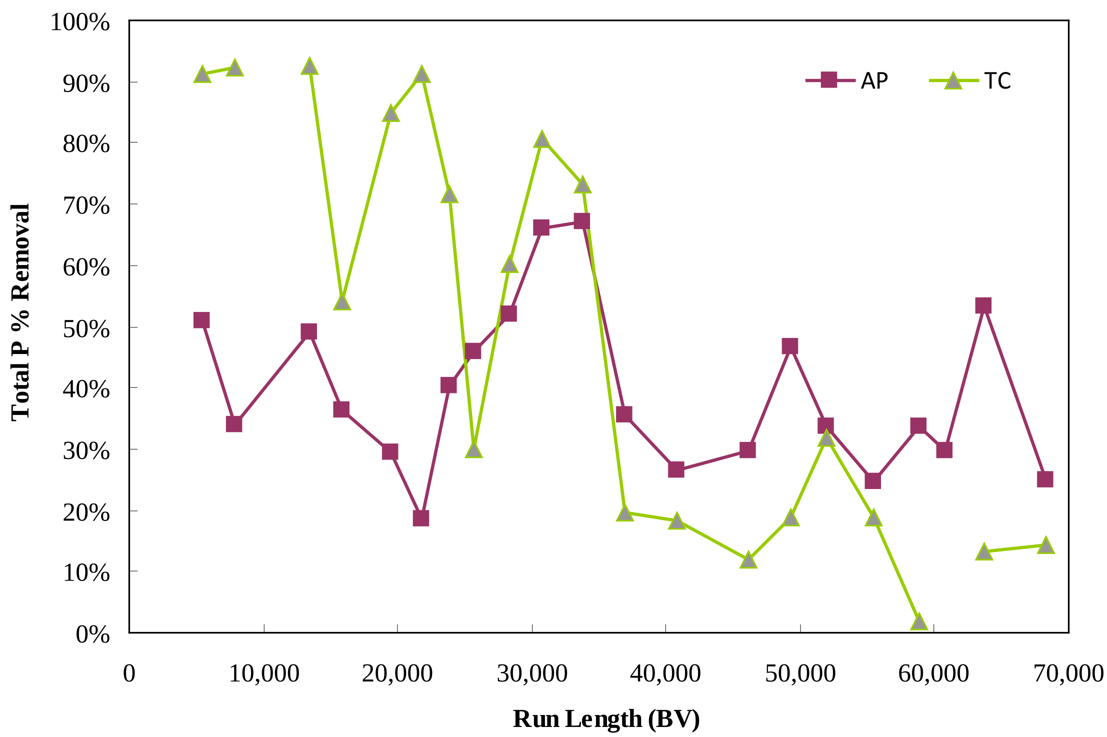


Figure 4-25. Total Phosphorus Percent Removal

measured in raw water with concentrations averaging only 1.8 µg/L. Total titanium concentrations following the adsorption vessel were low, ranging from 0.9 to 444 µg/L and averaging 16.3 µg/L. There were two instances where total titanium concentrations in the adsorption vessel effluent were high, i.e., 268 µg/L on March 10, 2009, and 444 µg/L on November 18, 2009. For the November 18, 2009, sample, the turbidity reading also was uncharacteristically high (9.9 NTU), indicating leakage of media fines into the vessel effluent. Soluble titanium concentrations remained at the background level of 1.4 µg/L throughout the treatment train.

4.5.2 Backwash Residual Sampling. Backwash wastewater samples were collected 12 times from each of the Birm®/Filox™ vessels. Table 4-11 presents analytical results of the Birm®/Filox™ backwash wastewater sampling. The Adsorbsia™ GTO™ vessel was backwashed only once for a test purpose; therefore, no samples were collected during its backwashing.

Table 4-11. Birm®/Filox™ Vessel Backwash Wastewater Sampling Results

Date	pH	TDS	TSS	As (total)	As (soluble)	As (particulate)	Fe (total)	Fe (soluble)	Mn (total)	Mn (soluble)	Ti (total)	Ti (soluble)
	S.U.	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Vessel A												
05/06/09	7.5	160	30.0	14.3	8.8	5.5	939	<25	1,022	1.7	653	1.9
06/02/09	7.8	178	13.0	15.8	10.6	5.3	632	96	516	138	3.4	1.4
06/29/09	7.7	162	20.0	25.2	11.8	13.4	3,306	372	614	122	12.4	2.3
08/12/09	7.6	162	13.0	28.7	12.4	16.3	2,437	37	720	33.6	6.5	1.7
11/19/09	7.7	166	22.0	26.6	9.1	17.4	1,824	<25	519	11.6	5.2	1.7
12/16/09	7.8	178	32.0	24.5	9.2	15.3	2,350	<25	229	10.7	410	1.8
01/12/10	7.7	164	24.0	36.1	9.3	26.8	3,056	<25	513	22.3	6.5	NA
02/10/10	7.8	148	16.0	26.1	10.9	15.2	2,975	253	458	64.7	3.8	2.0
03/10/10	7.9	158	24.0	29.3	9.0	20.4	2,828	<25	189	17.3	3.8	1.8
04/06/10	7.7	174	54.0	35.9	9.3	26.5	4,712	<25	650	24.2	6.7	1.7
05/03/10	7.9	162	32.0	92.8	17.7	75.2	3,366	960	526	153	7.4	2.6
06/07/10	7.7	164	38.0	48.7	12.5	36.2	4,983	<25	180	22.2	8.5	1.6
Average	***7.7***	***165***	***26.5***	***33.7***	***10.9***	***22.8***	***2,784***	***344***	***511***	***51.8***	***93.9***	***1.9***
Vessel B												
05/06/09	7.6	170	86.0	26.9	9.9	17.0	3,258	<25	1,422	16.0	379	1.9
06/02/09	7.8	180	26.0	29.3	9.7	19.6	2,415	<25	672	4.6	19.0	1.1
06/29/09	7.7	154	20.0	24.7	9.5	15.2	3,135	60	657	11.7	19.9	1.6
08/12/09	7.5	170	16.0	27.1	19.2	7.9	2,253	990	744	695	6.6	3.8
11/19/09	7.6	158	24.0	34.8	8.8	26.0	2,628	<25	490	12.6	5.6	1.7
12/16/09	7.7	176	33.0	25.7	9.4	16.3	2,599	<25	241	11.5	349	2.4
01/12/10	7.7	162	14.0	34.0	13.9	20.1	2,760	710	364	194	4.8	NA
02/10/10	7.7	148	18.0	31.7	9.4	22.3	3,745	<25	422	26.3	4.8	1.2
03/10/10	7.7	146	48.0	40.3	9.5	30.8	4,964	<25	240	48.1	4.9	1.6
04/06/10	7.6	168	42.0	30.8	9.4	21.5	3,423	<25	492	18.4	5.8	1.5
05/03/10	7.6	142	37.0	102	17.8	84.5	4,747	1,086	626	193	8.9	3.3
06/07/10	7.6	180	32.0	48.7	10.8	37.9	5,421	<25	658	21.8	8.7	1.9
Average	***7.6***	***163***	***33.0***	***38.0***	***11.4***	***26.6***	***3,446***	***711***	***586***	***104***	***68.1***	***2.0***

NA = not analyzed; TDS = total dissolved solids; TSS = total suspended solids

As shown in Table 4-11, results for the two vessels were comparable. pH values of backwash wastewater ranged from 7.5 to 7.9 and averaged 7.7, which was similar to that of the pre-oxidized water used for backwashing. TDS concentrations ranged from 142 to 180 mg/L and averaged 164 mg/L. TSS concentrations ranged from 13.0 to 86.0 mg/L and averaged 29.8 mg/L. TSS concentrations were low because the pre-oxidizing media was backwashed daily.

The backwash wastewater samples contained 14.3 to 102 µg/L of total arsenic, 632 to 5,421 µg/L of total iron, 180 to 1,422 µg/L of total manganese, and 3.4 to 653 µg/L of total titanium. As expected, the majority of these metals were present in the particulate form. Assuming that 752 gal of wastewater was produced when backwashing the two pre-oxidation vessels and that the wastewater contained 29.8 mg/L of TSS, it would discharge 85 g (0.2 lb) of solids. The waste stream would consist of 102 mg of arsenic, 8.9 g of iron, and 1.6 g of manganese based on 35.8 µg/L of total arsenic, 3,115 µg/L of total iron, and 548 µg/L of total manganese in the backwash wastewater. According to Table 4-9, concentration differences between the IN and AP locations were 2.8 µg/L of total arsenic, 276 µg/L of total iron, and 112 µg/L of total manganese (on average). Therefore, based on a daily water demand of 8,354 gal, the pre-oxidation vessels would remove 88.2 mg of total arsenic, 8.7 g of iron, and 3.5 g of manganese from raw water. The daily backwash recovered 116% of total arsenic, 102% of total iron, and 46% of total manganese from the pre-oxidation vessels. The low Mn recovery rate might be attributed to the fact that some manganese (existing as MnO_2) had attached to the oxidation media surface and was difficult to be washed off.

One set of backwash solid samples was collected on June 29, 2009 and analyzed in duplicate for ICP/MS metals. Table 4-12 presents the results of total metals analysis.

Table 4-12. Birm®/Filox™ Vessels Backwash Solid Sample Total Metal Results

Sample	Mg	Al	Si	P	Ca	Fe	Mn	Ni	Cu	Zn	As	Cd	Ba	Pb
BW1-A	5,469	20,589	15,629	2,584	8,573	42,466	17,006	34.0	60.0	172	130	<15	529	17.9
BW1-B	5,545	19,536	17,277	2,512	8,191	43,475	13,940	33.1	58.6	169	124	<15	500	16.3
Average	***5,507***	***20,063***	***16,453***	***2,548***	***8,382***	***42,971***	***15,473***	***33.6***	***59.3***	***171***	***127***	***<15***	***515***	***17.1***
BW2-A	5,140	17,693	12,842	2,103	8,247	37,512	13,412	26.6	38.8	132	100	<15	452	12.2
BW2-B	5,436	20,891	17,728	2,071	8,531	37,821	15,674	30.0	39.6	231	99.0	<15	456	13.6
Average	***5,288***	***19,292***	***15,285***	***2,087***	***8,389***	***37,667***	***14,543***	***28.3***	***39.2***	***182***	***100***	***<15***	***454***	***12.9***

Samples collected on 06/20/09; units in µg/g.

Total arsenic, iron, and manganese concentrations in the solids averaged 113, 40,319, and 15,008 µg/g. Assuming that the daily backwashing discharged 85 g of solids (dry weight), the solids would contain 9.6 mg of total arsenic, 3.4 g of total iron, and 1.3 g of total manganese. The amounts of total arsenic and iron were much lower than the values calculated based on the backwash wastewater data.

4.5.3 Distribution System Water Sampling. Prior to the installation/operation of the treatment system, four first-draw baseline distribution system water samples were collected at three locations, i.e., South House, South #1, and South #2, on July 16, August 13, August 20, and September 2, 2008. Following the installation of the treatment system, distribution water sampling continued on a monthly basis from January 2009 to November 2009. Table 4-13 presents results of the distribution system water sampling.

Table 4-13. Distribution System Sampling Results

Sampling Event		DS1								DS2								DS3							
		Stagnation Time	**pH**	**Alkalinity**	**As**	**Fe**	**Mn**	**Pb**	**Cu**	**Stagnation Time**	**pH**	**Alkalinity**	**As**	**Fe**	**Mn**	**Pb**	**Cu**	**Stagnation Time**	**pH**	**Alkalinity**	**As**	**Fe**	**Mn**	**Pb**	**Cu**
No.	**Date**	**hr**	**S.U.**	**mg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**hr**	**S.U.**	**mg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**hr**	**S.U.**	**mg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
BL1	07/16/08	11.5	7.5	140	14.2	391	37.7	0.2	5.7	4.0	7.6	142	12.5	<25	45.9	<0.1	18.2	12.5	7.6	144	11.1	<25	20.2	0.2	37.1
BL2	08/13/08	6.0	7.7	144	10.2	48	1.0	<0.1	2.0	8.0	7.6	137	10.7	41	57.9	<0.1	52.8	9.0	7.7	141	10.2	48	7.2	0.2	64.0
BL3	08/20/08	5.8	NA	NA	10.9	<25	6.3	<0.1	5.5	9.3	NA	NA	11.2	<25	24.1	<0.1	20.5	12.5	NA	NA	10.0	<25	3.8	0.2	86.4
BL4	09/02/08	7.5	7.6	144	10.7	87	1.8	<0.1	1.3	10.0	7.7	144	11.7	86	17.7	<0.1	11.2	11.5	7.8	142	10.6	68	10.7	<0.1	31.0
	Average	***7.7***	***7.6***	***143***	***11.5***	***135***	***11.7***	***<0.1***	***3.6***	***7.8***	***7.6***	***141***	***11.5***	***38***	***36.4***	***<0.1***	***25.7***	***11.4***	***7.7***	***142***	***10.5***	***36***	***10.4***	***0.2***	***54.6***
1	01/14/09	9.6	7.8	141	2.2	<25	21.4	<0.1	6.6	9.0	7.8	146	1.3	<25	3.2	0.4	48.7	5.2	8.0	141	5.1	<25	23.5	0.2	26.7
2	02/18/09	5.9	7.4	144	1.3	<25	25.2	<0.1	8.1	9.5	7.5	144	0.5	<25	0.4	<0.1	13.5	11.0	7.4	144	3.9	<25	14.9	0.5	109
3	03/19/09	17.5	7.6	145	0.4	<25	2.7	<0.1	47.1	8.7	7.5	145	0.3	<25	0.2	<0.1	10.7	11.5	7.7	135	3.7	<25	18.2	0.5	93.5
4	04/15/09	7.8	7.8	138	4.8	55	8.1	0.5	5.3	8.3	7.9	138	2.5	132	29.1	<0.1	5.3	12.0	8.0	134	5.1	114	34.3	0.9	124
5	05/13/09	12.0	8.0	142	3.3	76	10.6	0.8	269	12.0	7.8	145	1.8	<25	0.9	0.3	22.1	12.0	7.9	140	4.1	<25	2.5	0.6	107
6	06/10/09	11.0	7.6	145	4.9	<25	1.6	<0.1	6.5	7.8	7.7	145	1.4	<25	0.2	<0.1	11.2	11.8	7.6	145	3.8	<25	0.7	0.2	119
7	07/08/09	9.8	7.6	146	5.7	<25	9.6	<0.1	6.2	10.6	7.7	146	5.4	<25	20.6	<0.1	8.4	12.0	7.7	148	5.1	<25	5.0	<0.1	38.2
8	08/05/09	19.3	7.7	139	6.0	<25	0.6	<0.1	1.7	11.3	7.6	139	5.4	<25	12.9	0.1	30.0	11.3	7.5	137	5.2	<25	4.7	0.1	96.9
9	09/02/09	7.8	7.6	138	2.9	<25	1.4	<0.1	0.7	11.0	7.6	140	1.5	<25	6.3	0.3	57.7	11.0	7.5	138	3.0	<25	1.3	0.1	96.2
10	10/07/09	8.8	7.7	143	3.4	<25	2.4	<0.1	3.6	10.3	7.7	143	1.7	<25	4.1	<0.1	10.6	8.3	7.9	143	3.6	<25	4.9	0.3	121
11	11/04/09	7.5	7.7	136	3.3	<25	0.6	<0.1	3.0	9.8	7.6	134	1.7	<25	16.0	<0.1	18.4	8.5	7.7	138	3.0	<25	1.2	0.1	90.2
	Average	***10.6***	***7.7***	***142***	***3.5***	***<25***	***7.7***	***<0.1***	***32.5***	***9.8***	***7.7***	***142***	***2.1***	***<25***	***8.5***	***<0.1***	***21.5***	***10.4***	***7.7***	***140***	***4.1***	***<25***	***10.1***	***0.3***	***92.8***

NA = not available

The most noticeable change in the distribution samples since system startup was a decrease in arsenic, iron, and manganese concentrations. Baseline arsenic concentrations ranged from 10.0 to 14.2 µg/L and averaged 11.2 µg/L. After system startup, arsenic concentrations were reduced to 0.3 to 6.0 µg/L and averaged 3.2 µg/L. Baseline iron concentrations ranged from less than the MDL of 25 µg/L to 391 µg/L, and averaged 70 µg/L. After system startup, iron concentrations decreased to <25 µg/L (on average). Manganese had a similar trend with baseline concentrations averaging 19.5 µg/L and after-startup concentrations averaging 8.8 µg/L.

Lead and copper concentrations of all water samples collected before and after the installation of the treatment system were below the action level of 15 and 1,300 µg/L, respectively. The arsenic treatment system did not seem to have any effects on the lead or copper concentrations in the distribution system.

Measured pH values in distribution water ranged from 7.4 to 8.0 and averaged 7.7. Alkalinity levels ranged from 134 to 148 mg/L (as $CaCO_3$). The arsenic treatment system did not affect these water quality parameters of the distributed water.

4.6 System Cost

The system cost was evaluated based on the capital cost per gpm (or gpd) of design capacity and the O&M cost per 1,000 gal of water treated. Capital cost of the treatment system included the expenditure for equipment, site engineering, and system installation, shakedown, and startup. O&M cost included the expenditure for chemicals, electricity, and labor. Cost associated with the building was not included in the capital cost because it was outside the scope of this demonstration project and was funded separately by the HSMHP.

4.6.1 Capital Cost. The capital investment for the Birm®/Filox™ pre-oxidation and Adsorbsia™ GTO™ arsenic removal was $66,362 (Table 4-14). The equipment cost was $46,267 (or 70% of the total capital investment), which included costs for three 24-in × 72-in composite vessels, 10 ft^3 each of Birm®, Filox™, and Adsorbsia™ GTO, 6 ft^3 of garnet underbedding support, one backwash supply system, process valves and piping, instrumentation and controls, shipping, and labor.

The site engineering cost covered the expenditure for preparing the required engineering submittal, including a process design report, a general arrangement drawing, piping and instrumentation diagrams (P&IDs), electrical diagrams, interconnecting piping layouts, and obtaining the required permit approval from Utah DDW. The engineering cost of $3,850 was 6% of the total capital investment.

The installation, shakedown, and startup cost covered the labor and materials required to unload, install, and test the system for proper operation. The installation, startup and shakedown activities were performed by Filter Tech at a cost of $16,245 or 24% of the total capital investment.

The total capital cost of $66,362 was normalized to $2,212/gpm ($1.54/gpd) of design capacity using the system's rated capacity of 30 gpm (or 43,200 gpd). The total capital cost also was converted to an annualized cost of $6,264 gal/year using a capital recovery factor of 0.09439 based on a 7% interest rate and a 20-yr return period. Assuming that the system operated 24 hr/day, 7 day/week at the design flowrate of 30 gpm to produce 15,768,000 gal/yr, the unit capital cost would be $0.40/1,000 gal. During the demonstration study, the system produced 8,354 gal of water daily (Table 4-8) or 3,049,000 gal annually, the unit capital cost increased to $2.05/1,000 gal. These calculations did not include the building construction cost.

Table 4-14. Capital Investment for HSMHP System

Description	Quantity	Cost	% of Capital Investment
Equipment			
Adsorbsia™ GTO™ Media (ft^3)	10	$4,300	–
Birm® Media (ft^3)	10	$500	–
Filox™ Media (ft^3)	10	$1,600	–
Garnet (ft^3)	6	$35	–
24-in × 72-in Composite Vessels	3	$4,560	–
Backwash Supply System	1	$7,600	–
Process Valves and Piping	1	$3,900	–
Instrumentation	1	$6,875	–
Shipping	–	$2,400	–
Labor	–	$14,497	–
Equipment Total	**–**	**$46,267**	**70%**
Engineering			
Labor	1	$3,850	–
Engineering Total	**–**	**$3,850**	**6%**
Installation, Shakedown, and Startup			
Labor	1	$16,245	–
Installation, Shakedown, and Startup	**–**	**$16,245**	**24%**
Total Capital Investment	**–**	**$66,362**	**100%**

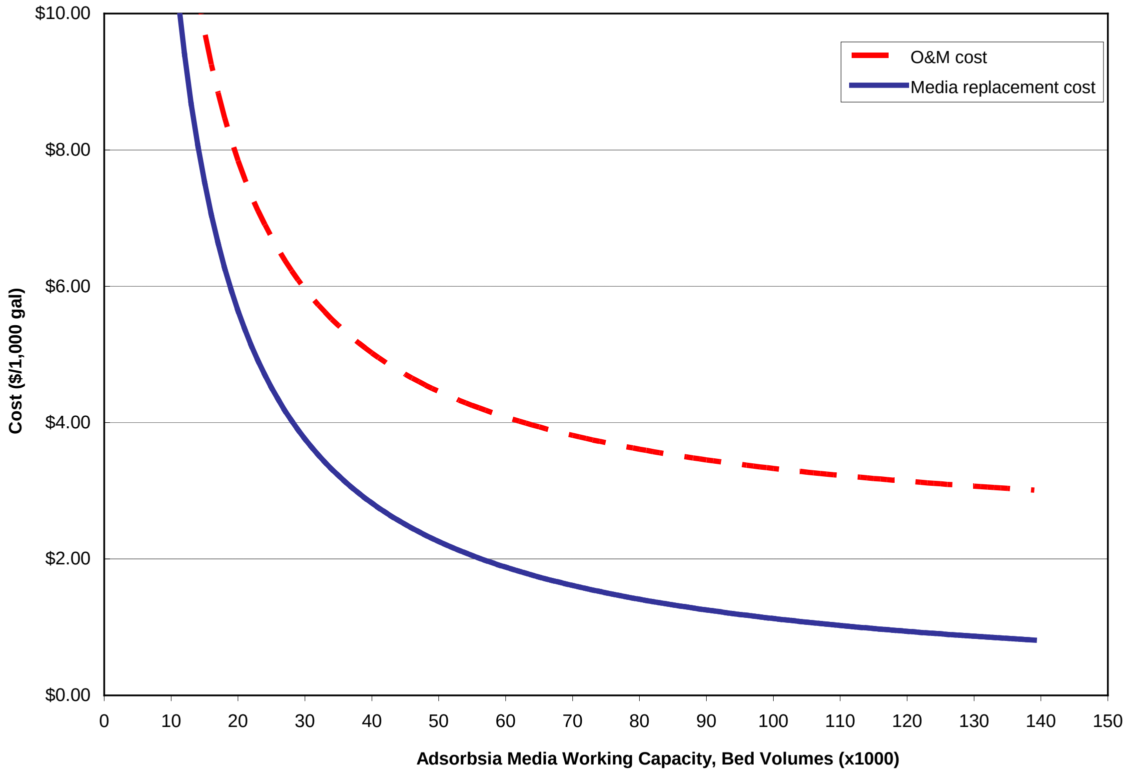
4.6.2 O&M Cost. The O&M cost includes cost for media replacement and disposal, electricity, and labor, as summarized in Table 4-15. Although neither the oxidizing nor the AM was replaced during the performance evaluation study, the media replacement cost would represent the majority of the O&M cost. It was estimated that the Birm®/Filox™ media would have a life expectancy of 10 years and that it would cost $8,175 to replace 20 ft^3 of media in two vessels (including the cost for media, labor, freight, and media disposal). At the current water use rate (i.e., 3,049,000 gal for one year), the system would treat 30,490,000 gal of water in a 10-yr period. Therefore, the Birm®/Filox™ media replacement cost would be equivalent to $0.27/1,000 gal of water treated.

It also was estimated that it would cost $8,440 to change out 10 ft^3 of Adsorbsia™ GTO™ media, including the cost for media, labor, freight, and media disposal. This cost was used to estimate the media replacement cost per 1,000 gal of water treated as a function of the projected media run length to the 10-μg/L arsenic breakthrough (Figure 4-26).

No cost was incurred for repairs because the system was under warranty. Electrical power consumption was calculated based on the difference between the average monthly cost from electric bills before and after the building construction and system startup. The difference in cost was approximately $100/month or $0.39/1,000 gal of water treated. The routine, non-demonstration related labor activities consumed approximately 30 min a day, six days a week. Based on this time commitment and a labor rate of $30/hr, the labor cost was $1.54/1,000 gal of water treated.

Table 4-15. O&M Costs for HSMHP System

Category	Value	Remarks
Volume Processed (×1,000 gal/year)	3,049	Based on average daily production of 8,354 gal
Media Replacement and Disposal		
Birm® Media	$500	10 ft^3
Filox™ Media	$1,600	10 ft^3
Freight	$1,810	Estimate
Subcontractor Labor Cost	$2,765	Estimate
Media Analysis and Disposal	$1,500	Estimate
Subtotal ($)	$8,175	
Birm®/ Filox™ Replacement and Disposal Cost ($/1,000 gal)	**$0.27**	Assuming 10-year media life treating 30,490,000 gal of water
Adsorbsia™ GTO™ Media	$4,300	10 ft^3
Freight	$625	Estimate
Subcontractor Labor Cost	$2,765	Estimate
Media Analysis and Disposal	$750	
Subtotal ($)	$8,440	
Adsorbsia™ GTO Replacement and Disposal Cost ($/1,000 gal)	**See Figure 4-26**	
Electricity Consumption		
Electricity Cost ($/month)	$100	Average incremental consumption after system startup, including building heating and lighting
Electricity Cost ($/1,000 gal)	**$0.39**	–
Labor		
Labor (hr/week)	3.0	30 min/day, 6 day/week
Labor Cost ($/1,000 gal)	$1.54	Labor rate = $30/hr
Total O&M Cost ($/1,000 gal)	**See Figure 4-26**	Total O&M cost = $2.20 + Adsorbsia™ GTO™ media replacement cost



Note: One bed volume equals 10 ft^3 (74.8 gal)

Figure 4-26. O&M Costs for HSMHP System

5.0 REFERENCES

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APPENDIX A

OPERATIONAL DATA

Table A-1. Operational Data for Hot Springs Mobile Home Park in Willard, UT

			Hour Meter (hr)		Pressure					Flowrate				Totalizer					
WK			Record	Diff	IN	TA	TB	AP	TC	IN	TA	TB	TC	IN	TA	TB	TC	Total BVs [(c)]	BW Totalizer
No.		Date	hr	hr	psi					gpm				gal				BVs	gal
1	Thu	12/11/08	(b)	(b)	55	58	55	NA	57	4.8	NA	NA	NA	238,989	NA (c)	4,142	7,924	103	12,566
	Fri	12/12/08	(b)	(b)	59	57	55	NA	59	(a)	4.0	3.2	7.2	238,989	NA (c)	8,430	16,925	220	NA (d)
	Sat	12/13/08	(b)	(b)	60	57	57	NA	60	(a)	3.5	3.4	6.9	NA (a)	NA (c)	11,172	22,715	295	NA (d)
2	Mon	12/15/08	(b)	(b)	65	55	55	NA	55	(a)	4.7	3.6	8.3	NA (a)	NA (c)	19,284	38,547	500	NA (d)
	Tue	12/16/08	(b)	(b)	65	59	57	NA	56	(a)	4.4	2.9	7.3	NA (a)	NA (c)	23,895	47,975	622	13,083
	Wed	12/17/08	(b)	(b)	62	57	57	57	57	(a)	4.2	3.4	7.6	NA (a)	NA (c)	27,380	55,094	715	13,083
	Thu	12/18/08	(b)	(b)	65	57	59	57	58	(a)	6.6	7.3	13.9	NA (a)	NA (c)	31,679	63,583	825	13,083
	Fri	12/19/08	(b)	(b)	60	55	55	55	55	(a)	2.1	2.4	4.5	NA (a)	NA (c)	37,150	73,731	956	13,083
	Sat	12/20/08	(b)	(b)	70	60	60	60	59	(a)	7.6	3.8	11.4	NA (a)	NA (c)	40,763	83,568	1,084	13,083
3	Mon	12/23/08	(b)	(b)	65	56	56	NA	55	(a)	2.0	1.5	3.5	NA (a)	NA (c)	52,158	109,740	1,423	13,083
	Tue	12/24/08	(b)	(b)	65	60	57	57	55	(a)	5.0	5.7	10.7	NA (a)	NA (c)	55,308	116,171	1,507	13,083
	Sat	12/27/08	(b)	(b)	75	65	65	57	57	(a)	5.4	5.2	10.6	NA (a)	NA (c)	68,370	146,430	1,899	13,083
4	Mon	12/29/08	(b)	(b)	65	60	58	57	56	(a)	4.6	0.8	5.4	NA (a)	NA (c)	79,578	168,646	2,187	13,083
	Tue	12/30/08	(b)	(b)	65	60	57	56	56	(a)	7.3	2.6	9.9	NA (a)	NA (c)	81,267	178,705	2,318	13,083
	Wed	12/31/08	(b)	(b)	65	59	57	56	55	(a)	3.9	1.1	5.0	NA (a)	NA (c)	83,751	187,370	2,430	13,083
	Sat	01/03/09	(b)	(b)	NA	59	57	56	56	(a)	4.5	4.7	9.2	NA (a)	NA (c)	96,554	225,967	2,931	13,083
5	Wed	01/07/09	1,467	(b)	60	59	59	59	54	14.0	7.0	4.3	11.3	253,142	NA (c)	118,075	277,336	3,597	13,955
	Thu	01/08/09	1,492	25	60	59	58	59	54	8.1	3.2	4.4	7.6	265,945	NA (c)	124,168	287,804	3,733	13,955
6	Mon	01/12/09	1,582	90	NA	60	59	59	54	10.8	3.6	6.8	10.4	312,648	NA (c)	145,973	326,870	4,240	14,721
	Tue	01/13/09	1,612	30	60	60	57	59	53	4.4	2.8	4.2	7.0	327,048	NA (c)	152,937	339,198	4,399	14,721
	Wed	01/14/09	1,629	17	60	56	56	58	52	5.8	1.3	2.0	3.3	335,912	NA (c)	157,443	346,792	4,498	14,721
	Fri	01/16/09	1,677	48	60	59	56	59	53	27.1	-1.1	10.7	9.6	358,116	NA (c)	168,713	365,864	4,745	15,100
7	Mon	01/19/09	1,751	74	60	58	56	58	54	0.0	-2.0	9.8	7.8	362,364	NA (c)	183,006	394,674	5,119	15,482
	Tue	01/20/09	1,771	20	60	56	55	56	52	0.0	2.6	3.0	5.6	362,364	NA (c)	186,938	402,209	5,217	15,482
	Wed	01/21/09	1,795	24	60	56	55	56	52	(d)	-1.3	4.7	3.4	(d)	NA (c)	NA (c)	410,667	5,326	15,482
	Thu	01/22/09	1,819	24	60	57	56	57	53	10.8	1.9	3.1	5.0	362,403	NA (c)	197,314	421,446	5,466	15,482
	Fri	01/23/09	1,846	27	61	58	58	59	54	12.6	3.7	6.4	10.1	375,683	NA (c)	202,992	431,629	5,598	17,010
	Sun	01/25/09	1,892	46	60	56	55	58	54	7.2	3.6	5.4	9.0	398,155	NA (c)	212,992	451,057	5,850	17,010
8	Mon	01/26/09	1,914	22	62	57	56	57	53	6.7	3.8	1.0	4.8	410,702	NA (c)	218,350	461,327	5,983	17,544
	Tue	01/27/09	1,937	23	58	57	57	59	54	9.0	8.9	3.0	11.9	423,328	NA (c)	221,890	472,235	6,125	17,544
	Wed	01/28/09	1,956	19	61	58	57	58	54	10.8	3.1	3.6	6.7	432,162	NA (c)	224,801	479,682	6,222	17,544
	Thu	01/29/09	1,983	27	58	56	55	58	53	3.1	3.5	0.9	4.4	445,683	NA (c)	230,005	490,221	6,358	18,197
	Fri	01/30/09	2,007	24	58	56	55	58	53	6.7	0.4	1.6	2.0	456,843	NA (c)	234,714	499,577	6,480	18,968
	Sat	01/31/09	2,024	17	58	56	55	58	56	6.9	2.9	3.1	6.0	463,684	NA (c)	237,471	504,841	6,548	19,743
9	Mon	02/02/09	2,080	56	60	56	56	57	56	8.4	3.1	4.2	7.3	489,359	NA (c)	247,608	526,337	6,827	21,049
	Tue	02/03/09	2,103	23	58	56	56	56	53	8.8	2.4	2.7	5.1	499,959	NA (c)	252,250	534,898	6,938	21,708
	Wed	02/04/09	2,124	21	61	58	56	58	53	12.8	3.3	5.8	9.1	509,572	NA (c)	256,345	542,498	7,036	22,482
	Thu	02/05/09	2,148	24	60	57	56	57	53	6.9	2.8	2.5	5.3	522,686	NA (c)	262,037	552,914	7,171	23,206
	Sat	02/07/09	2,192	44	60	59	58	59	53	9.9	3.1	4.1	7.2	545,835	NA (c)	272,255	571,440	7,412	24,696
10	Mon	02/09/09	2,235	43	59	56	56	57	53	1.4	2.5	2.6	5.1	565,499	NA (c)	280,133	587,353	7,618	26,254
	Tue	02/10/09	2,264	29	60	56	56	57	53	11.6	2.4	2.4	4.8	579,087	NA (c)	285,855	598,582	7,764	27,030
	Wed	02/11/09	2,281	17	57	56	56	57	53	1.8	-0.2	3.1	2.9	585,689	NA (c)	288,649	604,539	7,841	27,030
	Thu	02/12/09	2,310	29	58	60	60	60	54	31.1	-1.8	13.7	11.9	599,723	NA (c)	294,875	615,699	7,986	28,574
	Fri	02/13/09	2,331	21	60	57	57	58	53	6.4	2.6	3.0	5.6	609,242	NA (c)	298,988	623,764	8,090	28,574
11	Mon	02/16/09	2,402	71	63	59	58	59	53	14.4	4.1	4.8	8.9	638,738	NA (c)	308,648	648,991	8,418	30,027
	Tue	02/17/09	2,428	26	59	57	57	58	53	8.3	0.7	2.7	3.4	651,918	NA (c)	314,470	659,791	8,558	30,802
	Wed	02/18/09	2,451	23	58	56	56	57	53	4.5	2.3	1.6	3.9	662,115	NA (c)	318,818	667,976	8,664	31,577
	Thu	02/19/09	2,472	21	60	57	57	58	58	3.4	3.4	4.1	7.5	670,692	NA (c)	322,634	675,207	8,758	32,351
	Fri	02/20/09	2,495	23	58	56	56	56	53	9.2	-0.4	3.0	2.6	680,106	NA (c)	326,065	683,206	8,861	32,894
12	Mon	02/23/09	2,571	76	60	59	59	60	54	11.5	4.2	3.3	7.5	714,925	NA (c)	340,933	712,148	9,237	34,569
	Tue	02/24/09	2,590	19	62	59	59	60	54	14.4	4.1	5.5	9.6	723,048	NA (c)	344,462	718,562	9,320	35,348
	Wed	02/25/09	2,614	24	63	59	58	59	53	13.8	3.4	4.2	7.6	732,213	NA (c)	348,304	726,378	9,421	36,125
	Thu	02/26/09	2,637	23	60	56	56	57	54	18.0	-5.1	8.2	3.1	740,375	NA (c)	351,610	733,418	9,513	36,516

Table A-1. Operational Data for Hot Springs Mobile Home Park in Willard, UT (Continued)

WK No.		Date	Hour Meter (hr)		Pressure					Flowrate				Totalizer					
			Record	Diff	IN	TA	TB	AP	TC	IN	TA	TB	TC	IN	TA	TB	TC	Total BVs [c]	BW Totalizer
			hr	hr	psi					gpm				gal				BVs	gal
13	Mon	03/02/09	2,735	98	61	58	57	58	55	12.0	3.5	2.6	6.1	784,112	NA (c)	370,011	769,162	9,976	39,234
	Tue	03/03/09	2,749	14	60	56	56	58	56	9.3	5.6	4.3	9.9	789,256	NA (c)	372,163	773,307	10,030	40,012
	Wed	03/04/09	2,781	32	60	57	58	59	56	9.5	3.4	3.9	7.3	802,374	NA (c)	377,898	784,152	10,171	40,791
	Thu	03/05/09	2,803	22	62	58	58	60	55	12.3	2.5	5.4	7.9	811,459	NA (c)	382,003	791,584	10,267	41,570
	Fri	03/06/09	2,821	18	60	58	56	58	52	8.0	3.7	2.0	5.7	818,509	NA (c)	385,148	797,078	10,338	42,348
	Sat	03/07/09	2,843	22	60	56	50	40	52	10.5	1.7	5.0	6.7	825,876	NA (c)	388,424	803,352	10,420	43,126
14	Mon	03/09/09	2,893	50	66	60	60	60	54	10.9	7.8	5.0	12.8	847,139	NA (c)	397,822	820,976	10,648	44,492
	Tue	03/10/09	2,914	21	64	58	58	60	52	6.0	0.4	5.8	6.2	854,460	NA (c)	400,998	827,803	10,737	44,492
	Wed	03/11/09	2,940	26	64	60	60	60	52	11.8	3.6	5.6	9.2	863,344	NA (c)	404,826	835,404	10,835	44,878
	Thu	03/12/09	2,962	22	60	60	60	60	52	4.6	3.3	5.8	9.1	872,265	NA (c)	408,919	842,664	10,929	45,646
	Fri	03/13/09	2,983	21	60	58	58	58	52	10.1	3.1	3.1	6.2	881,322	NA (c)	412,912	850,206	11,027	46,425
	Sat	03/14/09	3,007	24	62	60	60	60	54	14.3	6.4	6.0	12.4	891,451	NA (c)	417,419	858,416	11,134	47,204
15	Mon	03/16/09	3,055	48	62	60	58	60	54	12.4	3.9	4.9	8.8	917,138	NA (c)	428,815	878,879	11,399	48,760
	Tue	03/17/09	3,077	22	60	58	58	60	54	8.2	1.4	4.7	6.1	927,076	NA (c)	433,388	887,054	11,505	49,539
	Wed	03/18/09	3,102	25	62	60	60	58	52	13.1	3.0	4.2	7.2	936,716	NA (c)	437,762	894,880	11,607	50,317
	Thu	03/19/09	3,125	23	60	56	56	56	52	3.5	1.9	2.4	4.3	945,813	NA (c)	441,835	902,245	11,702	51,095
	Fri	03/20/09	3,147	22	64	60	58	60	52	15.5	2.2	3.5	5.7	954,761	NA (c)	445,743	909,400	11,795	51,874
	Sat	03/21/09	3,171	24	60	56	56	56	52	0.0	1.2		1.2	964,647	NA (c)	449,981	917,267	11,897	52,652
16	Mon	03/23/09	3,219	48	64	58	58	60	52	16.0	3.1	3.9	7.0	984,484	NA (c)	458,922	933,756	12,111	53,434
	Tue	03/24/09	3,243	24	62	56	56	58	52	4.4	3.5	1.7	5.2	995,771	NA (c)	464,094	942,769	12,228	54,210
	Wed	03/25/09	3,265	22	60	56	56	58	52	5.2	3.5	1.7	5.2	1,004,384	NA (c)	467,951	949,870	12,320	54,988
	Thu	03/26/09	3,290	25	60	58	56	56	52	8.4	3.2	1.7	4.9	1,015,995	NA (c)	473,102	958,999	12,438	55,766
	Fri	03/27/09	3,313	23	62	58	58	58	52	8.0	0.8	5.8	6.6	1,024,715	NA (c)	476,971	966,787	12,539	55,766
	Sat	03/28/09	3,336	23	60	56	56	58	52	4.1	6.1	3.1	9.2	1,034,259	NA (c)	480,921	974,112	12,634	56,609
17	Mon	03/30/09	3,384	48	62	56	56	58	52	10.8	0.8	2.6	3.4	1,052,554	NA (c)	488,523	990,423	12,846	56,609
	Tue	03/31/09	3,407	23	60	56	54	56	52	4.1	4.7		4.7	1,062,249	NA (c)	492,823	998,516	12,951	57,127
	Wed	04/01/09	3,431	24	60	56	54	56	52	2.8	3.5	1.5	5.0	1,072,099	NA (c)	497,228	1,006,633	13,056	57,872
	Fri	04/03/09	3,477	46	56	56	56	56	54	4.8	7.6	3.7	11.3	1,078,723	NA (c)	500,375	1,011,586	13,120	59,044
	Sat	04/04/09	3,500	23	60	58	58	60	54	4.1	-0.4	3.2	2.8	1,085,487	NA (c)	503,426	1,017,244	13,194	59,426
18	Tue	04/07/09	3,572	72	80	70	70	70	52	8.1	5.5		5.5	1,098,548	NA (c)	504,856	1,028,231	13,336	59,852
	Wed	04/08/09	3,593	21	92	94	98	98	54	10.0	2.0	5.5	7.5	1,104,066	NA (c)	506,052	1,033,210	13,401	59,852
	Thu	04/09/09	3,619	26	60	58	58	60	54	9.7	6.0	7.6	13.6	1,116,714	17337	512,102	1,043,175	13,530	60,625
	Fri	04/10/09	3,641	22	58	58	58	58	54	2.3	0.8	0.6	1.4	1,125,172	18745	515,390	1,049,954	13,618	61,016
	Sat	04/11/09	3,665	24	58	58	56	58	54	2.9	2.0	1.8	3.8	1,133,069	20486	518,931	1,057,259	13,713	61,016
19	Mon	04/13/09	3,710	45	56	56	56	56	52	3.4	1.9		1.9	1,147,963	24093	525,085	1,071,107	13,892	61,019
	Tue	04/14/09	3,734	24	56	56	56	58	54	4.6	3.5	3.9	7.4	1,153,312	26837	529,456	1,079,430	14,000	61,433
	Wed	04/15/09	3,757	23	60	56	56	56	52	1.9	1.4		1.4	1,157,902	28582	533,271	1,086,555	14,093	62,060
	Thu	04/16/09	3,790	33	60	58	58	60	56	4.8	5.1	3.0	8.1	1,157,902	31191	539,230	1,098,374	14,246	62,060
	Fri	04/17/09	3,804	14	60	56	56	58	56	0.0	3.7	3.4	7.1	1,157,902	32319	541,076	1,102,347	14,298	62,510
	Sat	04/18/09	3,827	23	60	58	58	60	54	NA (a)	3.6	4.4	8.0	NA (a)	33577	544,611	1,109,191	14,386	65,934
20	Mon	04/20/09	3,875	48	60	56	56	58	56	(a)	4.8	6.7	11.5	NA (a)	37635	552,091	1,122,055	14,553	65,082
	Tue	04/21/09	3,898	23	56	56	56	58	52	(a)	3.5	2.0	5.5	NA (a)	39792	556,136	1,130,118	14,658	65,082
	Wed	04/22/09	3,920	22	58	56	56	58	54	(a)	3.3	3.6	6.9	NA (a)	41857	559,969	1,138,100	14,761	65,082
	Thu	04/23/09	3,947	27	56	58	56	58	54	(a)	2.7		2.7	NA (a)	NA (d)	564,607	1,147,483	14,883	65,082
	Fri	04/24/09	3,968	21	58	56	56	58	54	(a)	1.2	1.2	2.4	NA (a)	NA (d)	568,323	1,155,045	14,981	65,082
	Sat	04/25/09	3,993	25	58	58	56	58	54	(a)	2.0		2.0	NA (a)	NA (d)	572,558	1,163,713	15,094	65,082
21	Mon	04/27/09	4,038	45	58	56	56	58	54	(a)	-0.2	4.2	4.0	NA (a)	NA (d)	583,002	1,183,843	15,355	65,082
	Tue	04/28/09	4,060	22	58	56	56	58	54	(a)	8.4	2.6	11.0	NA (a)	NA (d)	587,296	1,192,689	15,469	65,082
	Wed	04/29/09	4,084	24	58	58	58	58	54	(a)	3.9	4.1	8.0	NA (a)	NA (d)	591,889	1,201,841	15,588	65,082
	Thu	04/30/09	4,108	24	58	56	56	58	54	(a)		3.4	6.2	NA (a)	61,800	595,872	1,210,121	15,695	65,082
	Fri	05/01/09	4,131	23	56	56	56	58	52	(a)		3.8	4.1	NA (a)	64,213	600,470	1,219,059	15,811	65,082
	Sat	05/02/09	4,156	25	56	56	56	56	56	(a)		1.9		NA (a)	64,605	600,984	1,219,711	15,820	65,082
22	Mon	05/04/09	4,204	48	56	56	56	56	55	(a)		1.9		NA (a)	64,918	601,350	1,219,914	15,822	65,082
	Tue	05/05/09	4,234	30	56	56	56	56	54	(a)				NA (a)	65,231	601,725	1,219,914	15,822	65,082
	Wed	05/06/09	4,246	12	56	56	54	56	54	(a)				NA (a)	65,231	601,725	1,219,914	15,822	65,082
	Thu	05/07/09	4,269	23	60	58	58	58	52	(a)	4.0	4.9	8.8	NA (a)	66,550	604,064	1,224,404	15,881	65,115
	Fri	05/08/09	4,294	25	60	56	56	58	54	(a)	3.6	4.0	9.6	NA (a)	69,381	608,311	1,233,634	16,000	66,746
	Sat	05/09/09	4,317	23	56	56	54	56	52	(a)		2.5	4.5	NA (a)	72,140	612,911	1,243,138	16,124	68,391

Table A-1. Operational Data for Hot Springs Mobile Home Park in Willard, UT (Continued)

WK No.		Date	Hour Meter (hr)		Pressure					Flowrate				Totalizer					
			Record	Diff	IN	TA	TB	AP	TC	IN	TA	TB	TC	IN	TA	TB	TC	Total BVs [c]	BW Totalizer
			hr	hr	psi					gpm				gal				BVs	gal
23	Mon	05/11/09	4,365	48	60	56	56	56	52	(a)		2.4	7.2	NA (a)	77,024	621,374	1,261,264	16,359	71,684
	Tue	05/12/09	4,389	24	58	56	56	58	54	(a)		2.1	5.2	NA (a)	81,038	626,795	1,270,399	16,477	73,333
	Wed	05/13/09	4,409	20	56	58	56	58	52	(a)	4.8		5.2	1,161,268	83,976	630,939	1,280,981	16,615	74,981
	Thu	05/14/09	4,435	26	60	58	58	58	54	(a)		4.7	9.5	NA (a)	NA (c)	637,309	1,293,501	16,777	76,632
	Fri	05/15/09	4,457	22	60	58	58	58	56	(a)	4.4	5.0	14.6	NA (a)	91,631	641,713	1,302,555	16,894	78,277
	Sat	05/16/09	4,482	25	60	58	58	60	56	(a)	6.7	8.3	15.8	NA (a)	94,112	645,853	1,311,662	17,012	79,925
24	Mon	05/18/09	4,535	53	60	58	57	59	56	(a)	3.2	3.5	6.5	NA (a)	101,879	657,090	1,334,494	17,309	84,879
	Tue	05/19/09	4,554	19	59	58	58	59	54	(a)	4.1	4.3	6.9	NA (a)	105,411	662,028	1,344,785	17,442	84,879
	Wed	05/20/09	4,577	23	58	56	56	58	55	(a)		1.0	3.9	NA (a)	108,938	667,418	1,355,330	17,579	86,537
	Thu	05/21/09	4,600	23	58	58	58	60	56	(a)	3.8	4.2	8.7	NA (a)	112,666	672,456	1,366,010	17,717	88,196
	Fri	05/22/09	4,623	23	60	58	58	58	56	(a)		2.3	7.5	NA (a)	117,445	678,415	1,378,043	17,873	89,855
	Sat	05/23/09	4,646	23	58	56	56	58	54	(a)			3.6	NA (a)	121,072	683,218	1,388,417	18,008	91,511
25	Mon	05/25/09	4,693	47	60	56	56	58	54	(a)			3.2	NA (a)	128,306	694,573	1,410,796	18,298	94,824
	Tue	05/26/09	4,716	23	60	58	58	58	54	(a)		3.9	7.8	NA (a)	132,269	700,067	1,422,128	18,445	96,475
	Wed	05/27/09	4,742	26	60	59	59	60	54	(a)		7.8	15.3	NA (a)	143,311	704,969	1,433,124	18,588	98,125
	Thu	05/28/09	4,767	25	62	60	59	60	55	(a)	12.8	11.6	8.7	NA (a)	140,171	710,826	1,445,012	18,742	100,614
	Fri	05/29/09	4,788	21	60	60	59	60	55	(a)	3.7	4.1	5.2	NA (a)	142,871	714,759	1,453,850	18,857	101,432
	Sat	05/30/09	4,814	26	60	58	58	59	55	(a)	10.8	9.8	5.9	NA (a)	146,487	720,088	1,465,447	19,007	103,919
26	Mon	06/01/09	4,858	44	58	56	56	58	55	(a)	3.5	3.8	5.4	NA (a)	151,306	727,956	1,483,268	19,238	106,383
	Tue	06/02/09	4,886	28	60	56	56	59	55	(a)	5.8	5.0	12.2	NA (a)	155,244	733,063	1,494,543	19,384	109,342
	Wed	06/03/09	4,906	20	60	58	58	59	55	(a)		3.6	6.7	NA (a)	157,207	736,943	1,503,067	19,495	109,342
	Thu	06/04/09	4,928	22	60	60	60	60	55	(a)	6.2	5.5	9.4	NA (a)	161,638	743,011	1,514,847	19,648	110,970
27	Tue	06/09/09	5,047	119	62	59	59	60	54	(a)		5.8	6.5	NA (a)	177,910	767,742	1,565,286	20,302	119,567
	Wed	06/10/09	5,070	23	60	56	56	59	56	(a)		2.7	5.3	NA (a)	180,358	771,549	1,573,514	20,409	120,891
	Thu	06/11/09	5,093	23	60	58	58	59	54	(a)		3.1	4.8	NA (a)	183,383	776,724	1,583,769	20,542	122,546
	Fri	06/12/09	5,116	23	60	59	59	60	54	0.0	4.8	4.8	9.8	1,161,538	185,828	780,718	1,592,245	20,652	124,199
	Sat	06/13/09	5,139	23	60	58	58	60	55	7.0	4.1	4.5	8.3	1,165,258	NA	783,105	1,597,186	20,716	NA
28	Mon	06/15/09	5,187	48	58	58	58	59	55	0.0	2.4	3.0	6.3	1,166,656	129,823	787,522	1,607,923	20,855	188,497
	Tue	06/16/09	5,211	24	58	56	56	59	55	3.7	3.0	5.0	10.4	1,171,437	131,956	789,576	1,612,710	20,917	189,270
	Wed	06/17/09	5,234	23	59	57	57	59	54	5.4	1.8	2.9	5.9	1,178,226	135,110	792,289	1,619,184	21,001	190,043
	Thu	06/18/09	5,259	25	58	58	58	59	55	3.7	5.8		5.1	1,184,201	137,828	794,594	1,624,333	21,068	191,281
	Fri	06/19/09	5,283	24	59	56	56	58	55	12.8	8.6	7.4	1.1	1,189,195	139,272	796,042	1,628,475	21,122	191,981
	Sat	06/20/09	5,306	23	59	58	58	60	55	4.0	5.6		5.4	1,194,099	141,336	797,626	1,632,578	21,175	193,140
29	Mon	06/22/09	5,354	48	59	58	58	59	55	4.9	3.0	3.3	6.4	1,204,901	146,082	801,214	1,641,879	21,295	194,692
	Tue	06/23/09	5,376	22	60	58	58	59	55	6.7	3.0	3.1	5.6	1,209,644	148,124	802,943	1,646,574	21,356	194,692
	Wed	06/24/09	5,399	23	58	57	56	58	55	4.5	NA (d)	NA (d)	2.4	1,214,828	150,602	804,887	1,651,270	21,417	195,462
	Thu	06/25/09	5,423	24	58	57	57	59	55	4.4	2.0	1.0	1.5	1,220,939	152,942	806,937	1,656,613	21,487	196,236
	Fri	06/26/09	5,450	27	59	58	58	60	55	6.5	3.3	3.6	7.2	1,227,402	155,857	809,357	1,661,882	21,555	197,789
	Sat	06/27/09	5,471	21	60	58	58	59	55	5.5		5.3	3.7	1,232,434	157,951	810,841	1,666,666	21,617	198,087
30	Tue	06/30/09	5,539	68	60	60	60	59	55	8.8	5.7	6.2	10.7	1,248,724	165,275	815,840	1,680,680	21,799	200,199
	Wed	07/01/09	5,565	26	60	57	56	59	56	12.8	9.9	9.0	2.6	1,255,563	168,421	818,354	1,686,390	21,873	201,324
	Thu	07/02/09	5,591	26	58	58	58	59	56	4.4	1.9	2.3	2.3	1,261,976	171,656	821,097	1,691,840	21,943	202,418
	Fri	07/03/09	5,613	22	59	58	58	59	55	7.0	4.3	3.1	6.0	1,266,747	173,766	822,947	1,696,041	21,998	203,038
	Sat	07/04/09	5,633	20	59	58	59	60	55	5.7	3.4	4.2	8.2	1,270,845	175,517	824,561	1,699,775	22,046	205,351
31	Mon	07/06/09	5,689	56	60	59	59	60	55	8.4	5.5	5.5	10.4	1,286,390	183,245	831,356	1,713,930	22,230	205,351
	Tue	07/07/09	5,704	15	59	60	60	60	56	4.9	4.9	4.2	7.7	1,289,335	184,445	832,255	1,716,500	22,263	205,351
	Wed	07/08/09	5,731	27	60	58	58	59	56	13.0	9.6	9.5	4.5	1,296,466	188,108	835,539	1,722,777	22,345	206,818
	Thu	07/09/09	5,752	21	58	56	56	58	56	3.4	2.0	1.1	3.0	1,301,399	189,955	837,221	1,727,035	22,400	206,818
	Fri	07/10/09	5,776	24	56	56	56	58	56	2.0	2.3	1.5	2.4	1,306,989	192,313	839,578	1,732,017	22,465	207,551
32	Mon	07/13/09	5,846	70	56	56	56	58	55	2.5	2.1	1.7	1.0	1,323,608	199,567	845,911	1,746,337	22,650	209,753
	Tue	07/14/09	5,868	22	58	58	58	59	55	5.2	1.7	1.6	5.5	1,328,491	201,822	847,831	1,750,767	22,708	210,124
	Wed	07/15/09	5,896	28	57	56	56	58	55	4.4	2.1		1.3	1,335,522	205,266	850,835	1,756,439	22,781	211,595
	Thu	07/16/09	5,917	21	59	59	59	60	55	15.0	11.1	11.5	8.3	1,340,779	207,481	851,544	1,761,151	22,842	212,330
	Fri	07/17/09	5,940	23	58	56	56	58	55	12.4	8.2	7.2		1,345,891	209,536	853,215	1,765,451	22,898	212,701
	Sat	07/18/09	5,962	22	60	60	60	60	55	8.1	3.6	1.9	7.4	1,350,847	211544	855,406	1,769,999	22,957	213,062
	Sun	07/19/09	5,990	28	60	60	60	60	55	5.5	2.4	1.8	8.7	1,359,665	216,412	859,522	1,777,955	23,060	214,530

Table A-1. Operational Data for Hot Springs Mobile Home Park in Willard, UT (Continued)

WK No.		Date	Hour Meter (hr) Record	Diff	Pressure IN	TA	TB	AP	TC	Flowrate IN	TA	TB	TC	Totalizer IN	TA	TB	TC	Total BVs (c)	BW Totalizer
			hr	hr	psi					gpm				gal				BVs	gal
	Mon	07/20/09	6,009	19	60	58	58	60	57	1.4	2.0		2.3	1,359,987	219,441	861,352	1,782,389	23,118	214,530
	Tue	07/21/09	6,032	23	58	58	58	60	57	0.0	1.5		5.9	1,359,987	221,473	863,882	1,787,916	23,190	215,263
	Wed	07/22/09	6,057	25	60	60	58	60	57	2.3		1.2	3.1	1,359,988	224,404	866,783	1,793,999	23,268	215,995
33	Thu	07/23/09	6,081	24	60	60	60	60	54	4.1	2.7	2.9	6.1	1,359,988	227,943	869,836	1,800,635	23,355	216,730
	Fri	07/24/09	6,104	23	60	60	60	60	54	7.1	3.5	3.7	10.9	1,359,988	231933	873,436	1,808,420	23,456	217,466
	Sat	07/25/09	6,127	23	62	60	60	60	57	0.0	3.7	4.2	8.1	1,359,988	235,200	877,125	1,816,454	23,560	218,999
	Sun	07/26/09	6,153	26	62	60	60	60	58	0.0	10.0		10.1	1,359,988	240,052	880,795	1,823,765	23,655	219,584
	Mon	07/27/09	6,175	22	60	57	57	57	58	0.0				1,359,988	242,872	883,291	1,829,522	23,729	219,668
	Tue	07/28/09	6,197	22	58	58	58	58	57	0.0			1.8	1,359,988	245,551	885,893	1,835,060	23,801	220,401
	Wed	07/29/09	6,221	24	62	58	58	60	57	0.0	2.8	3.0	9.0	1,359,988	248,560	888,347	1,840,810	23,876	221,135
34	Thu	07/30/09	6,244	23	60	58	58	60	57	0.0	3.7	0.9	3.5	1,359,988	251,233	890,840	1,846,173	23,945	221,869
	Fri	07/31/09	6,267	23	60	60	60	60	57	0.0	2.9	1.5	6.0	1,359,988	253,821	893,122	1,851,456	24,014	222,602
	Sat	08/01/09	6,291	24	60	60	60	60	57	0.0	4.0	3.2	5.2	1,359,988	257,229	896,190	1,858,135	24,100	223,335
	Sun	08/02/09	6,317	26	60	58	58	60	57	0.0		6.7	0.7	1,359,988	259872	898,470	1,863,366	24,168	224,440
	Mon	08/03/09	6,338	21	60	60	60	60	55	0.0	2.2	2.0	4.8	1,359,988	261,718	900,132	1,867,128	24,217	224,804
	Tue	08/04/09	6,363	25	58	56	56	56	56	0.0				1,359,988	264,992	902,940	1,873,525	24,300	225,530
	Wed	08/05/09	6,386	23	60	60	60	60	57	0.0	3.0	3.3	7.8	1,359,988	267,238	905,004	1,878,021	24,358	226,271
35	Thu	08/06/09	6,409	23	60	60	60	60	54	0.0	1.9	3.0	6.2	1,359,988	259,995	907,157	1,882,320	24,414	227,005
	Fri	08/07/09	6,430	21	60	60	60	54	54	0.0	2.7	2.6	5.5	1,359,988	272,262	908,498	1,887,825	24,485	227,376
	Sat	08/08/09	6,452	22	58	58	58	58	52	0.0	1.5			1,359,988	274,400	910,659	1,891,713	24,536	228,110
	Sun	08/09/09	6,479	27	60	58	58	58	56	4.8	4.3			1,364,697	276819	912,770	1,896,336	24,596	229,581
	Mon	08/10/09	6,499	20	60	60	60	60	52	6.2	3.2	3.2	11.0	1,370,433	279,661	915,071	1,902,032	24,670	229,581
	Tue	08/11/09	6,523	24	58	58	60	60	50	2.1	4.0	2.7	8.2	1,376,340	282,561	917,705	1,907,540	24,741	230,314
	Wed	08/12/09	6,546	23	58	57	57	57	54	1.6				1,382,067	285,192	920,032	1,912,533	24,806	231,049
36	Thu	08/13/09	6,570	24	58	57	57	57	52	0.0	1.3		3.9	1,387,845	287,912	922,633	1,917,955	24,876	231,971
	Fri	08/14/09	6,594	24	60	60	60	60	54	5.6	2.8	3.0	7.0	1,394,182	290,653	925,267	1,923,682	24,950	232,523
	Sat	08/15/09	6,619	25	60	60	60	60	54	6.4	3.2	3.4	6.9	1,399,110	292,499	927,227	1,927,931	25,006	233,255
	Sun	08/16/09	6,643	24	60	60	60	60	58	6.5	4.3	4.6	8.4	1,403,574	294,254	928,730	1,931,346	25,050	233,987
	Mon	08/17/09	6,666	23	60	60	60	60	54	7.6	3.9	4.1	7.8	1,408,281	296,294	930,660	1,935,462	25,103	234,721
	Tue	08/18/09	6,689	23	60	58	58	58	52	3.3	2.1	1.7	4.1	1,414,000	298,927	933,289	1,940,651	25,171	235,454
37	Wed	08/19/09	6,711	22	60	60	60	60	54	8.6	3.7	2.8	5.8	1,420,707	302,851	937,003	1,947,954	25,265	236,187
	Thu	08/20/09	6,737	26	60	58	58	58	52	3.5		2.5	5.8	1,430,939	308,574	943,205	1,959,826	25,419	236,921
	Fri	08/21/09	6,759	22	58	56	56	60	52	3.5			3.3	1,436,068	311,311	945,496	1,964,904	25,485	237,653
	Sat	08/22/09	6,784	25	58	56	56	61	52	3.5			3.3	1,442,023	313,308	947,491	1,969,582	25,546	238,384
	Mon	08/24/09	6,831	47	(d)	(d)	60	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	NA(d)	(d)
	Tue	08/25/09	6,855	24	(d)	(d)	57	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	NA(d)	(d)
38	Wed	08/26/09	6,878	23	60	58	57	58	52	6.8			2.3	1,445,458	316,095	949,958	1,975,402	25,621	238,384
	Thu	08/27/09	6,903	25	58	58	60	58	52	0.9			2.1	1,450,117	319,578	953,416	1,982,889	25,718	239,118
	Fri	08/28/09	6,925	22	60	58	60	58	54	0.0	2.0	3.5	6.5	1,451,072	323,269	957,096	1,990,531	25,818	239,852
	Sat	08/29/09	6,949	24	62	58	60	58	52	7.2	1.8	2.8	6.4	1,452,109	328,021	961,590	1,999,872	25,939	240,860
	Mon	08/31/09	6,996	47	60	60	60	60	52	6.3	2.5	2.3	9.9	1,474,550	338,763	972,029	2,021,022	26,213	242,052
	Tue	09/01/09	7,019	23	60	58	58	60	52	3.6	2.6	2.9	4.1	1,480,183	343,120	976,168	2,029,599	26,324	242,785
39	Wed	09/02/09	7,043	24	60	60	60	64	54	7.6	8.8	7.5	14.0	1,485,303	347,100	979,526	2,037,292	26,424	243,518
	Thu	09/03/09	7,067	24	60	58	58	58	52	4.5		2.8	2.3	1,490,714	350,956	983,084	2,045,330	26,528	244,250
	Fri	09/04/09	7,092	25	60	48	40	58	52	1.9			2.8	1,496,128	354,817	986,560	2,053,403	26,633	245,353
	Sat	09/05/09	7,114	22	60	60	60	60	52	5.3	5.0	5.0	8.1	1,499,994	357,443	989,108	2,058,904	26,704	245,715
	Mon	09/07/09	7,160	46	60	60	60	60	54	5.1	3.7	5.4	7.0	1,510,371	356,731	995,847	2,074,428	26,906	247,179
	Tue	09/08/09	7,184	24	58	60	60	60	54	1.8	3.9	4.0	3.5	1,514,906	367,874	998,858	2,081,181	26,993	247,911
40	Wed	09/09/09	7,204	20	58	58	56	58	52	0.0			6.2	1,518,865	370,698	1,001,646	2,086,852	27,067	248,643
	Thu	09/10/09	7,229	25	58	60	60	60	54	3.3	4.1		3.8	1,523,923	374,352	1,005,113	2,094,285	27,163	249,374
	Fri	09/11/09	7,252	23	60	60	60	60	52	1.2	4.4	4.4	6.5	1,528,644	377,651	1,008,215	2,101,305	27,254	250,107
	Sat	09/12/09	7,277	25	58	58	58	58	52	0.0			4.2	1,533,555	381,838	1,011,228	2,108,505	27,348	250,839
	Mon	09/14/09	7,324	47	60	60	58	60	54	3.3	1.0	1.6	5.0	1,543,363	382,785	1,017,436	2,123,085	27,537	252,302
	Tue	09/15/09	7,347	23	60	58	58	58	52	5.2	1.2		1.6	1,548,067	391,260	1,020,530	2,130,385	27,631	253,036
41	Wed	09/16/09	7,370	23	50	58	58	58	50	2.8		3.3	3.3	1,552,251	394,394	1,023,389	2,136,741	27,714	253,768
	Thu	09/17/09	7,395	25	60	58	58	58	52	2.7			5.5	1,557,526	398,037	1,027,123	2,145,002	27,821	254,500
	Fri	09/18/09	7,418	23	62	58	58	60	45	4.5	1.5		6.4	1,561,999	401,326	1,030,164	2,152,252	27,915	255,230
	Sat	09/19/09	7,440	22	60	58	58	58	52	2.1	2.2	0.6	3.8	1,565,569	403,713	1,032,305	2,157,519	27,983	255,961

Table A-1. Operational Data for Hot Springs Mobile Home Park in Willard, UT (Continued)

WK No.		Date	Hour Meter (hr) Record	Diff	Pressure IN	TA	TB	AP	TC	Flowrate IN	TA	TB	TC	Totalizer IN	TA	TB	TC	Total BVs [c]	BW Totalizer
			hr	hr	psi					gpm				gal				BVs	gal
42	Mon	09/21/09	7,487	47	60	60	60	60	54	5.4	5.1	5.4	12.7	1,574,687	410,318	1,038,723	2,172,051	28,172	257,424
	Tue	09/22/09	7,511	24	60	60	60	60	52	2.2		5.4	4.2	1,579,868	413,893	1,042,069	2,179,535	28,269	258,154
	Wed	09/23/09	7,535	24	60	58	58	60	54	3.4	3.0	2.8	6.1	1,584,197	417,491	1,045,212	2,187,124	28,367	258,887
	Thu	09/24/09	7,559	24	60	56	56	58	52	0.8			2.1	1,588,336	420,545	1,048,009	2,193,683	28,452	259,619
	Fri	09/25/09	7,582	23	58	58	58	58	54	3.2	1.7		6.7	1,593,647	424,891	1,051,993	2,202,246	28,564	260,351
	Sat	09/26/09	7,606	24	58	56	56	58	56	3.1				1,597,223	427,373	1,054,394	2,207,880	28,637	261,082
43	Mon	09/28/09	7,652	46	58	58	58	58	52	2.0	1.4		6.2	1,605,783	430,800	1,060,515	2,221,534	28,814	262,548
	Tue	09/29/09	7,676	24	60	60	60	60	52	3.7	2.3	1.4	4.5	1,610,121	434,139	1,063,513	2,228,222	28,900	263,279
	Wed	09/30/09	7,699	23	64	60	60	62	54	6.6		2.6	6.1	1,613,813	434,429	1,066,102	2,234,274	28,979	264,010
	Thu	10/01/09	7,723	24	60	60	60	60	52	4.1		2.6	5.8	1,618,263	434,429	1,069,040	2,241,442	29,072	264,742
	Fri	10/02/09	7,745	22	60	58	58	60	52	4.6		7.4	8.7	1,622,056	434,429	1,071,692	2,247,711	29,153	265,475
	Sat	10/03/09	7,769	24	60	60	60	60	1.6	0.7		9.2	6.6	1,627,122	434,429	1,075,152	2,255,837	29,259	266,206
44	Mon	10/05/09	7,817	48	60	58	58	60	52	1.5	1.42	3.0	2.8	1,636,148	434,429	1,081,492	2,270,696	29,451	267,668
	Tue	10/06/09	7,842	25	60	60	60	60	60	3.7	1.67			1,640,896	434,429	1,084,793	2,278,637	29,554	268,603
	Wed	10/07/09	7,861	19	60	60	60	60	50	4.7		5.9	11.9	1,645,322	434,429	1,087,960	2,285,753	29,647	269,130
	Thu	10/08/09	7,887	26	60	58	60	60	54	0.0		4.1	10.6	1,649,693	434,429	1,091,113	2,293,098	29,742	269,862
	Fri	10/09/09	7,912	25	62	60	60	60	54	4.0		2.5	5.7	1,654,777	434,429	1,094,556	2,301,482	29,851	270,593
	Sat	10/10/09	7,934	22	60	58	58	58	54	5.8		4.4	14.3	1,658,826	434,429	1,097,555	2,308,202	29,938	271,326
45	Mon	10/12/09	7,980	46	60	60	60	60	52	5.1		5.4		1,668,071	434,429	1,103,991	2,323,452	30,136	272,790
	Tue	10/13/09	8,004	24	60	58	60	60	54	3.3		4.2	6.2	1,672,510	434,429	1,106,915	2,330,707	30,230	273,519
	Wed	10/14/09	8,026	22	60	60	60	60	54	2.3			3.3	1,676,206	434,429	1,109,271	2,336,480	30,305	274,250
	Thu	10/15/09	8,051	25	60	60	60	60	52	3.9		3.4	4.9	1,680,579	434,429	1,111,934	2,343,501	30,396	274,981
	Fri	10/16/09	(d)		60	60	60	60	54	6.6		3.9	9.4	1,683,951	434,429	1,114,109	2,348,754	30,464	275,712
	Sat	10/17/09	8,078		58	60	60	60	52	6.3		6.0	3.8	1,687,983	434,429	1,116,829	235,038	3,048	276,444
46	Mon	10/19/09	8,147	69	62	60	60	60	58	3.8		2.5	4.8	1,697,054	434,429	1,122,944	2,369,435	30,732	277,903
	Tue	10/20/09	8,169	22	60	60	60	60	50	4.8		7.2	12.6	1,701,056	434,429	1,125,776	2,375,824	30,815	278,632
	Wed	10/21/09	8,193	24	62	60	60	60	54	7.3	4.1	3.9	8.4	1,705,500	437,605	1,128,843	2,382,650	30,903	279,364
	Thu	10/22/09	8,216	23	60	58	58	60	54	3.7	4.4	3.6		1,709,506	440,743	1,131,367	2,388,941	30,985	280,095
	Fri	10/23/09	8,237	21	58	60	58	60	52	2.9	1.8		3.8	1,713,671	444,079	1,134,374	2,395,582	31,071	280,827
	Sat	10/24/09	8,262	25	60	60	60	60	58	0.0	2.5		2.4	1,717,717	447,377	1,137,264	2,402,054	31,155	281,557
47	Mon	10/26/09	8,307	45	58	58	58	60	52	1.9	3.0	2.1	8.4	1,726,030	453,761	1,142,910	2,415,037	31,323	283,019
	Tue	10/27/09	8,333	26	58	60	60	60	54	3.9	4.0		2.4	1,732,734	459,230	1,149,532	2,426,015	31,466	283,745
	Wed	10/28/09	8,351	18	60	60	60	60	54	8.0		3.1	5.0	1,738,257	467,315	1,159,160	2,434,871	31,581	284,479
	Thu	10/29/09	8,377	26	60	60	60	60	54	4.6	5.8	2.2	7.7	1,746,157	470,303	1,158,507	2,447,950	31,750	285,210
	Fri	10/30/09	8,400	23	60	60	60	60	54	5.5	3.8	5.9	9.2	1,753,132	476,092	1,164,308	2,459,509	31,900	285,943
	Sat	10/31/09	8,424	24	62	60	60	62	54	6.9	6.0	6.0	9.7	1,759,780	481,627	1,169,808	2,470,782	32,046	286,673
48	Mon	11/02/09	8,470	46	60	58	58	60	54	0.0	1.6	1.5	5.1	1,768,067	488,271	1,176,314	2,485,974	32,244	288,133
	Tue	11/03/09	8,493	23	58	56	56	58	52	1.0			1.3	1,773,087	491,448	1,179,588	2,493,313	32,339	288,862
	Wed	11/04/09	8,514	21	60	58	58	58	52	2.3			2.5	1,777,097	494,347	1,182,563	2,499,812	32,423	289,591
	Thu	11/05/09	8,540	26	60	58	58	60	54	0.0	2.8	0.9	4.1	1,781,489	497,332	1,185,646	2,507,134	32,518	290,321
	Fri	11/06/09	8,562	22	64	60	60	64	56	7.4	5.6	5.6		1,785,839	500,449	1,188,641	2,514,145	32,609	291,049
	Sat	11/07/09	8,587	25	60	60	60	60	54	3.7	3.7	3.8	6.6	1,790,114	503,701	1,191,723	2,521,232	32,701	291,775
49	Mon	11/09/09	(d)		60	60	60	60	54	5.9	3.3	4.1	9.1	1,799,415	511,136	1,199,145	2,537,113	32,907	293,230
	Tue	11/10/09	8,658		60	60	60	60	54	4.4	4.3	4.4	10.2	1,804,352	514,827	1,203,061	2,545,364	33,014	293,958
	Wed	11/11/09	8,681	23	60	58	58	60	54	10.9	9.2	8.8	5.9	1,808,710	517,935	1,206,517	2,550,347	33,078	295,053
	Thu	11/12/09	8,704	23	62	60	60	60	54	5.5	2.6	2.4	1.2	1,812,856	521,306	1,209,596	2,559,116	33,192	295,413
	Fri	11/13/09	8,727	23	60	60	60	60	54	4.5	2.3	3.1	6.2	1,817,130	524,675	1,213,160	2,566,105	33,283	296,138
	Sat	11/14/09	8,754	27	62	60	58	60	52	5.9			8.3	1,822,319	528,472	1,217,117	2,574,426	33,391	297,371
50	Mon	11/16/09	8,798	44	64	60	60	60	54	6.7	9.6		8.1	1,831,719	535,047	1,223,991	2,590,710	33,602	297,905
	Tue	11/17/09	8,820	22	60	58	58	60	52	2.5	2.8	2.2	4.8	1,836,562	538,809	1,227,093	2,599,530	33,716	297,911
	Wed	11/18/09	8,844	24	60	60	60	60	54	3.8		6.5	6.3	1,841,679	542,738	1,231,382	2,607,937	33,825	299,007
	Thu	11/19/09	8,867	23	60	58	58	60	54	2.8	3.2	4.1	9.5	1,845,715	545,795	1,234,774	2,614,507	33,911	299,371
	Fri	11/20/09	8,890	23	60	60	60	60	54	5.3	4.5	6.7	14.2	1,850,118	548,995	1,238,314	2,621,729	34,004	300,103
	Sat	11/21/09	8,914	24	60	60	58	60	54	3.6	2.4	3.5	6.7	1,854,130	552,220	1,241,329	2,628,168	34,088	300,829

Table A-1. Operational Data for Hot Springs Mobile Home Park in Willard, UT (Continued)

WK No.		Date	Hour Meter (hr) Record	Hour Meter (hr) Diff	Pressure IN	Pressure TA	Pressure TB	Pressure AP	Pressure TC	Flowrate IN	Flowrate TA	Flowrate TB	Flowrate TC	Totalizer IN	Totalizer TA	Totalizer TB	Totalizer TC	Total BVs [(c)]	BW Totalizer
			hr	hr	psi					gpm				gal				BVs	gal
51	Mon	11/23/09	8,960	46	64	60	60	60	54	5.8		6.0	12.3	1,865,510	556,696	1,249,025	2,643,830	34,291	302,282
	Tue	11/24/09	8,963	3	58	58	56	60	52	1.9	1.0			1,868,884	560,259	1,252,953	2,651,923	34,396	303,007
	Wed	11/25/09	9,008	45	65	62	60	62	54	7.0	5.9	5.4	10.7	1,876,085	566,009	1,258,775	2,662,905	34,538	304,086
	Thu	11/26/09	9,030	22	70	68	64	66	56	16.3	5.6	7.5	13.8	1,880,060	569,041	1,261,849	2,669,540	34,624	304,445
	Fri	11/27/09	9,054	24	64	60	60	64	54	1.6	6.6	4.7	8.7	1,885,154	572,863	1,265,759	2,677,557	34,728	305,191
	Sat	11/28/09	9,077	23	58	58	58	60	54	1.4				1,889,196	576,004	1,268,654	2,683,854	34,810	305,898
52	Mon	11/30/09	9,129	52	60	54	54	58	52	0.0				1,897,846	582,826	1,275,114	2,697,443	34,986	307,350
	Tue	12/01/09	9,146	17	60	58	60	58	55	3.3	3.5		3.3	1,902,856	586,752	1,278,855	2,705,781	35,094	308,075
	Wed	12/02/09	9,171	25	64	60	60	60	54	0.0		6.6	6.5	1,908,426	591,035	1,282,837	2,713,841	35,199	308,894
	Thu	12/03/09	9,195	24	60	56	59	60	54	0.0	2.2	1.0	8.8	1,913,451	594,816	1,286,690	2,721,568	35,299	309,995
	Fri	12/04/09	9,216	21	62	64	64	64	62	1.4	3.5	5.8	9.3	1,918,786	595,437	1,289,516	2,729,578	35,403	309,998
	Sat	12/05/09	9,240	24	60	60	60	60	54	5.0		3.7	7.8	1,923,200	599,027	1,293,031	2,737,844	35,510	310,215
53	Mon	12/07/09	9,280	40	62	60	60	62	54	4.1	4.4	4.6	9.9	1,933,973	606,856	1,299,258	2,755,210	35,736	310,892
	Tue	12/08/09	9,307	27	64	61	60	60	54	6.0	2.6	3.2	6.2	1,938,947	610,652	1,302,509	2,763,742	35,846	310,892
	Wed	12/09/09	9,339	32	62	62	60	60	54	2.6	3.1	3.3	6.0	1,944,845	614,956	1,305,564	2,772,846	35,964	310,986
	Thu	12/10/09	9,389	50	62	60	60	62	54	5.6	5.1	3.5	7.7	1,953,967	621,960	1,312,359	2,786,878	36,146	311,713
	Fri	12/11/09	9,377	-12	62	60	60	60	54	5.6	5.1	5.5	9.2	1,960,358	626,693	1,317,370	2,797,192	36,280	311,713
	Sat	12/12/09	9,400	23	66	60	60	60	56	9.9	5.2	3.8	11.1	1,966,816	631,340	1,322,207	2,806,892	36,406	312,436
54	Mon	12/14/09	9,448	48	56	54	54	54	48	5.0			5.6	2,000,317	649,282	1,340,333	2,843,624	36,882	313,858
	Tue	12/15/09	9,472	24	56	54	54	54	52	9.7	4.7	5.0	2.6	2,006,833	649,711	1,340,572	2,843,882	36,886	315,280
	Wed	12/16/09	9,493	21	62	60	60	60	52	7.3	5.8	4.4	4.2	2,012,104	653,263	1,344,275	2,852,123	36,993	315,280
	Thu	12/17/09	9,516	23	62	60	60	64	54	8.5	7.0	7.0	15.0	2,018,391	657,677	1,348,786	2,861,742	37,117	316,004
	Fri	12/18/09	9,541	25	60	60	60	60	54	7.0	6.1	6.2	5.0	2,024,588	662,165	1,353,022	2,871,329	37,242	316,723
	Sat	12/19/09	9,564	23	60	58	58	58	54	2.0	3.6	4.2	4.9	2,031,182	667,010	1,357,783	2,881,433	37,373	317,443
55	Mon	12/21/09	(d)	(d)	60	58	58	58	54	5.0	3.7	3.2	6.4	2,043,674	676,100	1,366,143	2,899,666	37,609	319,010
	Tue	12/22/09	9,634	(d)	60	58	58	60	54	5.3	1.0	1.6	5.7	2,048,629	679,782	1,369,303	2,907,857	37,715	319,610
	Wed	12/23/09	9,657	23	60	58	58	60	54	12.9	12.8	12.6	12.0	2,054,776	684,014	1,373,515	2,919,058	37,861	320,698
	Thu	12/24/09	9,681	24	58	58	58	58	54	0.0			6.5	2,060,257	687,957	1,376,887	2,925,571	37,945	321,053
	Fri	12/25/09	9,706	25	60	60	60	60	54	6.0	4.3	5.2	10.7	2,068,825	694,571	1,383,375	2,938,044	38,107	322,500
	Sat	12/26/09	9,727	21	62	60	60	60	48	14.0	13.7	13.4	14.2	2,074,389	698,288	1,387,185	2,947,018	38,223	322,869
56	Mon	12/28/09	9,771	44	62	60	60	60	54	7.5	4.8	4.0	7.8	2,088,333	708,533	1,397,692	2,968,239	38,499	323,850
	Tue	12/29/09	9,796	25	62	60	60	60	54	7.5	5.2	8.8	16.6	2,095,967	716,555	1,406,203	2,984,743	38,713	324,674
	Wed	12/30/09	9,818	22	60	60	60	60	54	7.3	5.2	5.2	8.8	2,107,504	723,006	1,412,936	2,997,774	38,882	325,399
	Thu	12/31/09	9,843	25	62	58	58	58	54	16.6	10.7	11.1	7.1	2,116,820	730,050	1,420,492	3,011,856	39,064	326,492
	Fri	01/01/10	9,865	22	64	60	60	60	54	8.8	7.3	7.5	14.0	2,124,639	736,015	1,426,626	3,024,158	39,224	326,850
	Sat	01/02/10	9,888	23	64	60	60	62	56	8.6	7.3	4.0	19.0	2,132,963	742,131	1,433,172	3,036,944	39,390	327,575
57	Mon	01/04/10	9,938	50	62	60	60	62	56	4.6	7.7	7.9	15.8	2,151,996	756,680	1,448,135	3,065,883	39,765	329,752
	Tue	01/05/10	9,954	16	60	60	60	60	54	6.3	4.5	4.5	9.6	2,159,073	761,985	1,453,704	3,077,342	39,914	329,752
	Wed	01/06/10	9,983	29	64	60	60	60	50	14.5	12.2	12.6	15.6	2,168,003	768,751	1,461,015	3,080,841	39,959	331,203
	Thu	01/07/10	10,005	22	64	58	58	60	54	7.7		7.2	10.1	2,173,375	772,538	1,464,551	3,099,727	40,204	331,326
	Fri	01/08/10	10,028	23	60	58	58	60	52	6.5	4.9	4.2	8.1	2,179,907	777,041	1,468,880	3,109,690	40,333	331,929
	Sat	01/09/10	10,053	25	60	60	60	60	54	5.1		3.4		2,188,878	783,236	1,475,971	3,122,821	40,504	333,800
58	Mon	01/11/10	10,097	44	60	58	58	58	55	3.1		5.7	8.5	2,200,539	787,304	1,483,370	3,141,676	40,748	334,105
	Tue	01/12/10	10,120	23	58	58	58	60	54	4.6	3.0	2.0	3.9	2,206,645	791,446	1,488,404	3,151,083	40,870	334,837
	Wed	01/13/10	10,144	24	62	58	58	60	55	1.7	6.7		4.4	2,213,194	796,446	1,494,029	3,161,892	41,010	336,295
	Thu	01/14/10	10,166	22	66	62	62	62	56	10.6	7.0	7.5	16.4	2,222,107	802,570	1,500,662	3,175,361	41,185	336,245
	Fri	01/15/10	10,191	25	64	62	62	64	56	8.0	7.6	8.2	14.3	2,236,025	812,944	1,511,968	3,197,348	41,470	337,019
	Sat	01/16/10	10,215	24	70	66	66	66	58	11.2		20.9	22.3	2,249,134	822,955	1,522,488	3,218,012	41,738	338,769
59	Mon	01/18/10	10,263	48	62	60	60	60	54	17.5	13.8	12.7	12.0	2,274,468	842,090	1,542,669	3,227,680	41,864	334,559
	Tue	01/19/10	10,285	22	64	60	60	60	54	6.8	5.2	6.0	10.3	2,285,420	850,461	1,551,512	3,275,090	42,478	39,912
	Wed	01/20/10	10,309	24	60	58	58	60	54	3.7			2.2	2,293,013	855,715	1,557,374	3,287,026	42,633	340,634
	Thu	01/21/10	10,334	25	58	58	58	60	54	4.4	3.7		6.4	2,299,572	860,395	1,562,086	3,296,868	42,761	342,076
	Fri	01/22/10	10,357	23	64	58	58	58	54	15.9	13.0	12.9	11.8	2,306,819	865,880	1,567,957	3,308,635	42,914	342,798
	Sat	01/23/10	10,381	24	60	60	60	62	52	5.1	5.2	3.4	6.5	2,315,507	872,354	1,574,936	3,322,246	43,090	343,545

Table A-1. Operational Data for Hot Springs Mobile Home Park in Willard, UT (Continued)

WK No.		Date	Hour Meter (hr) Record	Diff	Pressure IN	TA	TB	AP	TC	Flowrate IN	TA	TB	TC	Totalizer IN	TA	TB	TC	Total BVs [c]	BW Totalizer
			hr	hr	psi					gpm				gal				BVs	gal
60	Mon	01/25/10	10,428	47	62	60	60	60	54	14.4	11.4	11.5	13.0	2,336,879	883,917	1,592,579	3,356,592	43,536	344,959
	Tue	01/26/10	10,451	23	60	60	60	60	54	5.3	5.2	5.4	9.4	2,344,489	894,612	1,598,941	3,369,820	43,707	344,959
	Wed	01/27/10	10,474	23	66	62	62	64	54	10.9	7.2	6.5	13.1	2,353,199	901,320	1,605,768	3,384,048	43,892	345,680
	Thu	01/28/10	10,498	24	58	58	58	60	54	5.0		6.7	7.4	2,361,017	907,451	1,612,429	3,397,194	44,062	346,689
	Fri	01/29/10	10,523	25	62	58	58	60	54	3.0	2.1	2.3	5.2	2,370,669	914,867	1,620,021	3,412,148	44,256	347,837
	Sat	01/30/10	10,,546	23	62	58	58	60	50	13.5	13.4	13.2	12.6	2,377,090	919,548	1,625,624	3,423,264	44,400	348,203
61	Mon	02/01/10	10,593	47	62	60	60	60	54	6.0	8.9		9.0	2,392,177	930,880	1,638,220	3,448,262	44,725	349,884
	Tue	02/02/10	10,615	22	62	62	62	64	54	8.7	7.3	7.2	15.6	2,398,649	936,715	1,644,381	3,460,993	44,890	349,996
	Wed	02/03/10	10,640	25	60	60	60	60	54	13.0	11.9	11.8	10.3	2,408,220	944,408	1,652,493	3,476,433	45,090	351,431
	Thu	02/04/10	10,661	21	64	64	64	64	54	8.7	7.1	7.0	13.6	2,414,620	949,199	1,657,627	3,487,526	45,234	351,431
	Fri	02/05/10	10,686	25	60	60	60	60	54	3.5	2.3	5.0	8.9	2,421,882	954,941	1,663,550	3,499,677	45,391	352,147
	Sat	02/06/10	10,708	22	62	58	58	60	54	2.7	3.2	2.6	4.7	2,428,313	960,011	1,668,778	3,510,333	45,530	352,865
62	Mon	02/08/10	10,754	46	68	60	60	60	54	6.7	6.2	6.5	13.5	2,440,749	969,743	1,677,517	3,531,353	45,802	354,300
	Tue	02/09/10	10,779	25	60	58	58	60	54	11.8	10.9	4.8	5.2	2,448,258	975,768	1,683,586	3,543,744	45,963	355,381
	Wed	02/10/10	10,801	22	60	60	60	60	54	2.6	2.0	5.6	11.1	2,455,083	981,212	1,689,089	3,555,269	46,112	355,736
	Thu	02/11/10	10,825	24	62	60	60	60	54	5.1	5.3	6.0	10.5	2,461,858	986,729	1,694,712	3,566,860	46,263	356,461
	Fri	02/12/10	10,849	24	64	58	58	60	54	12.7	10.9	10.1	9.8	2,469,390	992,630	1,701,791	3,579,438	46,426	357,542
	Sat	02/13/10	10,872	23	60	58	58	60	54	4.3	1.5	6.6	12.9	2,475,247	996,615	1,705,012	3,589,329	46,554	354,895
63	Mon	02/15/10	10,918	46	62	58	58	60	54	4.1	6.4	3.2	9.5	2,488,135	1,006,034	1,715,517	3,610,512	46,829	359,328
	Tue	02/16/10	10,940	22	58	60	60	60	54	3.5		6.2	10.6	2,494,897	1,011,086	1,720,926	3,621,666	46,974	360,048
	Wed	02/17/10	10,965	25	60	56	56	60	54	0.0		2.9	5.1	2,501,056	1,015,374	1,725,508	3,631,966	47,107	361,122
	Thu	02/18/10	10,987	22	60	60	60	60	54	3.2	3.5	3.0	6.3	2,505,547	1,018,715	1,729,091	3,640,157	47,213	361,476
66	Mon	03/08/10	11,408	421	58	60	60	60	54	3.8	5.1	6.4	9.6	2,589,144	1,081,927	1,795,500	3,788,635	49,139	374,365
	Tue	03/09/10	11,438	30	58	60	60	60	54	6.9	1.1	3.4	8.1	2,593,740	1,085,429	1,799,097	3,796,463	49,241	375,081
	Wed	03/10/10	11,457	19	60	60	60	60	54	3.6	6.0	6.2	24.0	2,598,241	1,088,941	1,802,718	3,804,506	49,345	375,825
	Thu	03/11/10	11,480	23	58	56	56	56	52	0.0			3.4	2,602,338	1,092,061	1,806,328	3,811,682	49,438	376,411
	Fri	03/12/10	11,503	23	60	58	58	60	54	5.2		2.9	3.7	2,606,313	1,095,050	1,810,180	3,818,626	49,528	377,125
	Sat	03/13/10	11,527	24	62	60	60	60	54	6.4	3.9	4.3	11.6	2,610,170	1,097,936	1,813,528	3,825,453	49,617	377,838
67	Mon	03/15/10	11,570	43	60	58	58	60	54	1.2	2.5	3.1	6.8	2,619,321	1,105,231	1,821,350	3,840,791	49,816	379,972
	Tue	03/16/10	11,594	24	58	58	58	58	54	3.6	3.3	2.6	3.7	2,624,493	1,109,079	1,825,468	3,849,299	49,926	379,988
	Wed	03/17/10	11,624	30	64	64	64	64	54	4.5	5.9	5.0		2,630,281	1,113,576	1,829,933	3,858,122	50,040	381,422
	Thu	03/18/10	11,641	17	62	60	60	60	54	6.5	3.9	4.2	9.1	2,632,219	1,114,900	1,831,352	3,861,954	50,090	381,422
	Fri	03/19/10	11,668	27	58	58	58	58	54	0.0				2,636,449	1,118,156	1,832,021	3,869,209	50,184	382,399
	Sat	03/20/10	11,689	21	58	58	58	58	54	3.8	1.2	4.1	11.2	2,639,753	1,120,778	1,834,555	3,874,633	50,255	(d)
68	Mon	03/22/10	11,736	47	62	58	58	60	54	6.4	2.1			2,647,606	1,126,382	1,840,782	3,887,637	50,423	384,287
	Tue	03/23/10	11,765	29	62	60	60	60	54	6.1	4.9	4.4	6.6	2,652,807	1,130,820	1,844,857	3,895,850	50,530	385,716
	Wed	03/24/10	11,783	18	58	58	58	60	54	0.6				2,654,976	1,132,318	1,846,530	3,900,011	50,584	385,716
	Thu	03/25/10	11,806	23	62	60	60	60	54	5.7	4.9	4.4	7.1	2,658,067	1,134,603	1,848,902	3,905,229	50,651	386,430
	Fri	03/26/10	11,833	27	62	60	60	60	54	7.7	3.5	2.4	5.9	2,664,158	1,139,372	1,849,694	3,914,956	50,778	387,857
	Sat	03/27/10	11,855	22	60	60	60	60	54	0.0	2.7		5.9	2,666,705	1,141,248	1,849,694	3,920,219	50,846	387,857
69	Mon	03/29/10	11,900	45	60	58	58	58	54	0.0			2.6	2,674,374	1,146,879	1,849,694	3,933,158	51,014	389,285
	Tue	03/30/10	11,928	28	60	60	60	60	54	2.5	4.9	12.1	6.1	2,675,326	1,151,021	1,849,694	3,942,042	51,129	390,706
	Wed	03/31/10	11,948	20	60	58	58	58	54	0.0	2.2	14.1	6.0	2,675,326	1,153,873	1,849,694	3,949,036	51,220	390,706
	Thu	04/01/10	11,975	27	60	60	60	60	54	7.4	5.8	4.7	8.0	2,675,326	1,159,037	1,854,410	3,959,607	51,357	392,128
	Fri	04/02/10	11,997	22	60	60	60	60	54	9.6	1.0		3.5	2,675,326	1,161,934	1,857,636	3,966,542	51,447	392,841
	Sat	04/03/10	12,022	25	70	60	60	60	54	0.0	3.6	4.2	9.1	2,675,326	1,166,402	1,862,329	3,976,304	51,573	393,552
70	Mon	04/05/10	12,064	42	60	58	58	58	54	16.5	1.9		2.2	2,675,326	1,174,458	1,870,221	3,993,691	51,799	394,264
	Tue	04/06/10	12,087	23	60	58	58	58	54	18.9			8.1	2,675,326	1,178,505	1,874,563	4,002,821	51,917	394,972
	Wed	04/07/10	12,110	23	60	58	58	58	54	0.0			6.6	2,675,326	1,183,145	1,878,816	4,012,027	52,037	395,091
	Thu	04/08/10	12,137	27	60	60	60	60	54	0.0	1.4		3.1	2,675,326	1,188,617	1,883,652	4,021,982	52,166	397,109
	Fri	04/09/10	12,150	13	62	60	60	60	54	0.0	3.2	3.2	9.3	2,675,326	1,191,909	1,886,724	4,028,986	52,257	397,109
	Sat	04/10/10	12,179	29	62	60	60	60	54	0.0	3.3	3.7	6.5	2,675,326	1,196,750	1,891,311	4,038,577	52,381	397,813
71	Mon	04/12/10	12,225	46	62	60	60	60	54	0.0	4.7	5.0	9.7	2,675,326	1,206,932	1,900,873	4,058,943	52,645	399,218
	Tue	04/13/10	12,249	24	60	60	60	60	54	0.0	4.0	2.8	5.9	2,675,326	1,211,280	1,905,522	4,068,006	52,763	399,917
	Wed	04/14/10	12,273	24	62	60	60	60	54	0.0	4.5	4.1	12.6	2,675,326	1,215,907	1,910,211	4,077,685	52,888	400,621
	Thu	04/15/10	12,295	22	62	60	60	60	54	0.0	3.2	3.9	7.6	2,675,326	1,219,838	1,914,177	4,086,087	52,997	401,329
	Fri	04/16/10	12,319	24	60	60	60	60	54	0.0	2.4		7.4	2,675,326	1,224,633	1,918,949	4,096,385	53,131	402,021
	Sat	04/17/10	12,344	25	60	60	60	60	54	0.0	3.8	5.5	11.9	2,675,326	1,229,270	1,923,507	4,106,285	53,259	402,718

Table A-1. Operational Data for Hot Springs Mobile Home Park in Willard, UT (Continued)

			Hour Meter (hr)		Pressure					Flowrate				Totalizer					
WK No.		Date	Record	Diff	IN	TA	TB	AP	TC	IN	TA	TB	TC	IN	TA	TB	TC	Total BVs [c]	BW Totalizer
			hr	hr	psi					gpm				gal				BVs	gal
72	Mon	04/19/10	12,389	45	60	58	58	58	54	0.0	2.9		7.8	2,675,326	1,238,575	1,932,920	4,126,103	53,516	404,109
	Tue	04/20/10	12,412	23	60	60	60	60	54	0.0	3.5	4.4	8.1	2,675,326	1,242,915	1,937,052	4,135,333	53,636	404,803
	Wed	04/21/10	12,435	23	64	64	64	64	54	0.0	5.1	4.1	7.9	2,675,326	1,247,693	1,942,022	4,145,437	53,767	465,497
	Thu	04/22/10	12,460	25	62	60	60	60	54	0.0	4.8	4.7	9.1	2,675,326	1,252,446	1,946,923	4,155,662	53,900	406,194
	Fri	04/23/10	12,492	32	60	60	60	60	54	0.0	3.9	3.1	12.3	2,675,326	1,259,346	1,953,930	4,169,751	54,082	407,590
	Sat	04/24/10	12,506	14	70	70	70	70	54	0.0	9.2	8.8	17.0	2,675,326	1,262,211	1,956,698	4,176,270	54,167	407,590
73	Mon	04/26/10	12,553	47	60	60	60	58	54	0.0		7.3	3.7	2,675,326	1,270,344	1,964,720	4,193,125	54,386	408,984
	Tue	04/27/10	12,576	23	60	60	60	60	54	0.0	6.2	6.3	12.8	2,675,326	1,274,466	1,969,083	4,202,038	54,501	409,679
	Wed	04/28/10	12,601	25	60	60	60	64	54	0.0	3.7	5.0	6.5	2,675,326	1,278,622	1,973,435	4,211,428	54,623	410,373
	Thu	04/29/10	12,624	23	60	60	60	60	54	0.0	2.2	1.8	6.5	2,675,326	1,282,966	1,977,765	4,220,892	54,746	411,065
	Fri	04/30/10	12,649	25	64	60	60	60	59	0.0	7.2	5.5	12.1	2,675,326	1,287,971	1,982,933	4,231,339	54,881	411,761
	Sat	05/01/10	12,671	22	60	60	60	62	54	0.0	3.1	5.5	9.8	2,675,326	1,294,428	1,989,581	4,244,442	55,051	412,458
74	Mon	05/03/10	12,714	43	58	58	58	58	54	0.0				2,675,326	1,302,729	1,997,853	4,261,452	55,272	413,847
	Tue	05/04/10	12,741	27	62	58	58	58	54	0.0		7.3	3.2	2,675,326	1,306,496	2,001,432	4,269,426	55,375	414,549
	Wed	05/05/10	12,764	23	60	60	60	60	54	0.0	2.5	6.3	11.7	2,675,326	1,309,384	2,004,467	4,275,925	55,459	415,239
	Thu	05/06/10	12,789	25	64	60	60	60	54	0.0		5.0	8.6	2,675,326	1,313,279	2,008,627	4,284,305	55,568	416,282
	Fri	05/07/10	12,811	22	70	60	60	60	54	0.0	3.0	1.8	8.8	2,675,326	1,318,228	2,013,580	4,294,384	55,699	416,621
	Sat	05/08/10	12,835	24	62	56	56	56	54	0.0		5.5		2,675,326	1,321,047	2,016,302	4,300,460	55,778	417,313
75	Mon	05/10/10	12,888	53	60	60	60	60	54	0.0	2.7	2.7	8.7	2,675,326	1,328,468	2,023,138	4,315,555	55,973	419,377
	Tue	05/11/10	12,913	25	60	64	64	64	54	0.0	3.0	3.5	9.8	2,675,326	1,331,217	2,025,600	4,321,530	56,051	420,063
	Wed	05/12/10	12,925	12	64	64	64	64	54	0.0	6.0	4.0	11.5	2,675,326	1,333,666	2,027,836	4,326,720	56,118	420,750
	Thu	05/13/10	12,952	27	68	64	64	64	54	0.0	5.9	5.7	6.5	2,675,326	1,337,833	2,032,445	4,335,941	56,238	420,750
	Fri	05/14/10	12,974	22	58	60	60	60	54	0.0	3.7		9.7	2,675,326	1,342,089	2,037,130	4,345,605	56,363	421,437
	Sat	05/15/10	12,999	25	64	60	60	60	54	0.0	2.5	2.6	5.6	2,675,326	1,344,911	2,039,877	4,351,825	56,444	422,119
76	Mon	05/17/10	13,046	47	64	60	60	60	54	0.0	2.4	2.6	5.9	2,675,326	1,352,316	2,047,318	4,367,957	56,653	423,480
	Tue	05/18/10	13,068	22	66	62	62	62	54	0.0	4.7	5.2	10.6	2,675,326	1,355,781	2,050,775	4,375,487	56,751	424,189
	Wed	05/19/10	13,091	23	60	60	60	60	54	0.0	2.6	3.0	6.7	2,675,326	1,358,789	2,053,600	4,382,143	56,837	424,839
	Thu	05/20/10	13,115	24	58	56	56	56	54	0.0				2,675,326	1,361,262	2,055,861	4,387,545	56,907	425,520
	Fri	05/21/10	13,139	24	58	60	60	60	54	0.0	2.3		1.5	2,675,326	1,363,695	2,057,977	4,392,810	56,975	426,204
	Sat	05/22/10	13,165	26	58	58	58	58	54	0.0		7.0	11.6	2,675,326	1,366,344	2,060,470	4,398,698	57,052	427,237
77	Mon	05/24/10	13,209	44	60	58	58	58	54	0.0	2.1	6.4		2,675,326	1,370,965	2,064,938	4,409,818	57,196	428,260
	Tue	05/25/10	13,233	24	60	60	60	60	54	0.0			3.6	2,675,326	1,374,797	2,068,149	4,416,480	57,282	428,947
	Wed	05/26/10	13,256	23	60	60	60	60	54	0.0	3.4	3.7	7.6	2,675,326	1,378,544	2,072,605	4,425,983	57,406	429,631
	Thu	05/27/10	13,276	20	64	60	60	60	54	0.0	4.0	2.9	6.9	2,675,326	1,383,379	2,077,536	4,436,850	57,547	430,313
	Fri	05/28/10	13,305	29	62	60	60	60	54	0.0	3.8	4.1	8.4	2,675,326	1,389,999	2,084,298	4,450,553	57,724	430,990
	Sat	05/29/10	13,335	30	62	56	56	56	54	0.0	4.6	5.3	10.6	2,675,326	1,344,846	2,089,180	4,461,645	57,868	432,350
78	Mon	05/31/10	13,384	49	60	58	58	58	62	0.0	2.8	2.8	7.9	2,675,326	1,402,946	2,097,465	4,481,095	58,121	433,710
	Tue	06/01/10	13,401	17	64	60	60	60	56	0.0	8.4	8.4	8.5	2,675,326	1,406,231	2,100,593	4,488,416	58,216	439,394
	Thu	06/03/10	13,446	45	68	60	60	60	55	0.0	4.6	4.6	9.4	2,675,326	1,415,761	2,110,030	4,508,539	58,477	435,677
	Fri	06/04/10	13,477	31	60	60	60	60	54	0.0		2.5	11.6	2,675,326	1,420,380	2,114,161	4,517,488	58,593	436,435
	Sat	06/05/10	13,498	21	62	60	60	60	54	0.0	3.7	4.6	7.1	2,675,326	1,423,045	2,116,832	4,522,970	58,664	437,110
79	Mon	06/07/10	13,540	42	64	64	64	64	56	0.0	5.2	6.3	11.2	2,675,326	1,428,909	2,122,533	4,536,322	58,837	437,783
	Tue	06/08/10	13,564	24	60	60	60	60	54	0.0	4.5	5.4	14.3	2,675,326	1,432,578	2,126,139	4,544,139	58,938	438,463
	Wed	06/09/10	13,589	25	64	60	60	60	54	0.0	10.2	10.3	5.8	2,675,326	1,436,602	2,130,040	4,552,147	59,042	439,811
	Thu	06/10/10	13,610	21	60	60	60	60	54	0.0	3.1	3.1		2,675,326	1,438,842	2,132,104	4,557,362	59,110	439,811
	Fri	06/11/10	13,634	24	66	60	60	60	54	0.0	6.4	5.6	7.9	2,675,326	1,442,310	2,135,484	4,564,887	59,207	440,488
	Sat	06/12/10	13,657	23	64	60	60	60	54	0.0	2.8	3.4	6.6	2,675,326	1,444,921	2,138,113	4,570,568	59,281	441,167
80	Mon	06/14/10	13,705	48	64	64	64	64	54	0.0	3.8	3.9	6.3	2,675,326	1,449,748	2,142,822	4,580,966	59,416	442,530
	Tue	06/15/10	13,728	23	60	60	60	60	54	0.0	4.0	5.1	10.3	2,675,326	1,452,565	2,145,500	4,587,272	59,498	443,206
	Wed	06/16/10	13,752	24	58	58	58	58	54	0.0				2,675,326	1,455,828	2,148,727	4,594,719	59,594	443,882
	Thu	06/17/10	13,778	26	66	58	58	58	54	0.0				2,675,326	1,459,673	2,152,419	4,601,812	59,686	445,231
	Fri	06/18/10	13,799	21	60	60	60	60	54	0.0	2.8	2.1	4.9	2,675,326	1,461,476	2,153,834	4,606,153	59,743	445,231
	Sat	06/19/10	13,820	21	70	60	60	60	54	0.0	3.7	3.8	7.6	2,675,326	1,463,916	2,155,662	4,610,622	59,801	445,908
81	Fri	06/25/10	13,963	143	64	60	60	60	54	0.0	3.5	1.9	5.9	2,675,326	1,472,595	2,161,647	4,625,600	59,995	447,590
	Sat	06/26/10	13,992	29	64	66	70	70	54	0.0	8.3	5.3	12.7	2,675,326	1,482,454	2,171,192	4,644,302	60,237	448,935

Table A-1. Operational Data for Hot Springs Mobile Home Park in Willard, UT (Continued)

WK No.		Date	Hour Meter (hr) Record	Diff	Pressure IN	TA	TB	AP	TC	Flowrate IN	TA	TB	TC	Totalizer IN	TA	TB	TC	Total BVs (c)	BW Totalizer
			hr	hr	psi					gpm				gal				BVs	gal
82	Mon	06/28/10	14,034	42	60	64	64	64	54	0.0	2.5	2.2	5.4	2,675,326	1,492,925	2,180,743	4,665,540	60,513	449,612
	Tue	06/29/10	14,064	30	64	60	60	60	54	0.0	3.4	5.2	9.2	2,675,326	1,500,761	2,188,124	4,680,284	60,704	450,963
	Wed	06/30/10	14,082	18	60	60	60	66	54	0.0	0.6		4.7	2,675,326	1,503,177	2,196,379	4,685,629	60,773	450,963
	Thu	07/01/10	14,111	29	64	62	64	66	54	0.0	3.4	3.7	6.9	2,675,326	1,508,457	2,195,475	4,696,270	60,911	452,311
	Fri	07/02/10	14,134	23	74	60	60	60	54	0.0	5.1	4.8	6.5	2,675,326	1,512,976	2,199,674	4,703,089	61,000	452,987
	Sat	07/03/10	14,153	19	68	66	66	60	54	0.0	6.9	7.2	14.6	2,675,326	1,517,819	2,204,383	4,713,266	61,132	452,987
83	Tue	07/06/10	14,223	70	60	64	64	64	54	0.0		4.2	2.9	2,675,326	1,517,819	1,522,801	4,734,597	61,409	455,024
	Wed	07/07/10	14,245	22	62	58	58	58	54	0.0			1.4	2,675,326	1,517,819	1,522,801	4,742,804	61,515	455,702
	Thu	07/08/10	14,271	26	62	58	58	58	54	0.0			1.6	2,675,326	1,517,819	1,522,801	4,752,056	61,635	456,379
	Fri	07/09/10	14,293	22	60	60	60	60	54	0.0	2.5		5.9	2,675,326	1,517,819	1,526,797	4,760,829	61,749	457,055
	Sat	07/10/10	14,317	24	64	60	60	60	54	0.0	2.8	2.8	6.7	2,675,326	1,517,819	1,530,306	4,769,146	61,857	457,728
84	Mon	07/12/10	14,365	48	68	66	66	72	54	0.0	8.4	7.5	16.7	2,675,326	1,517,819	1,539,227	4,786,917	62,087	459,071
	Tue	07/13/10	14,388	23	60	58	58	58	54	0.0				2,675,326	1,517,819	1,543,766	4,795,434	62,198	460,744
	Wed	07/14/10	14,414	26	64	64	64	64	54	0.0	11.3	10.4	5.4	2,675,326	1,547,806	2,243,428	4,803,358	62,300	460,759
	Thu	07/15/10	14,436	22	60	60	60	60	54	0.0			6.7	2,675,326	1,551,148	2,246,342	4,810,782	62,397	461,090
	Fri	07/16/10	14,456	20	60	60	60	60	54	0.0		4.5	6.5	2,675,326	1,555,802	2,250,609	4,820,373	62,521	461,764
	Sat	07/17/10	14,481	25	64	60	60	60	54	0.0	1.4	1.9	4.9	2,675,326	1,559,469	2,254,013	4,828,115	62,621	462,436
85	Mon	07/19/10	14,529	48	62	60	60	60	54	0.0	2.2	2.9	5.6	2,675,326	1,559,734	2,264,243	4,849,237	62,895	463,777
	Tue	07/20/10	14,553	24	64	60	60	60	54	0.0	4.6	4.8	10.1	2,675,326	1,573,786	2,267,869	4,857,426	63,002	464,446
	Wed	07/21/10	14,576	23	66	64	64	64	54	0.0	5.2	6.0	7.5	2,675,326	1,577,444	2,271,200	4,865,672	63,109	465,120
	Thu	07/22/10	14,600	24	68	64	64	64	54	0.0	4.8	5.1	12.4	2,675,326	1,580,660	2,274,131	4,871,001	63,178	465,789
	Fri	07/23/10	14,626	26	68	66	66	66	54	0.0	3.7	2.5	5.9	2,675,326	1,585,679	2,279,220	4,882,020	63,321	467,131
	Sat	07/24/10	14,647	21	64	64	64	64	54	0.0	4.2	3.1	6.7	2,675,326	1,588,583	2,282,104	4,888,929	63,410	467,131
86	Mon	07/26/10	14,694	47	62	60	60	60	54	0.0	3.6	3.9	14.2	2,675,326	1,596,177	2,288,603	4,904,263	63,609	468,472
	Tue	07/27/10	14,717	23	62	60	60	60	54	0.0	2.7	2.5	8.9	2,675,326	1,601,036	2,292,737	4,913,954	63,735	469,142
	Wed	07/28/10	14,740	23	70	70	70	70	54	0.0	7.4	7.7	9.3	2,675,326	1,606,355	2,297,217	4,924,687	63,874	469,810
	Thu	07/29/10	14,765	25	66	66	66	66	54	0.0	5.4	5.7	11.4	2,675,326	1,610,805	2,301,206	4,934,266	63,998	470,478
	Fri	07/30/10	14,788	23	64	68	68	68	54	0.0	7.1	6.2	9.7	2,675,326	1,614,072	2,303,794	4,940,001	64,073	471,146
	Sat	07/31/10	14,813	25	64	60	60	60	54	0.0	11.1	10.2	3.6	2,675,326	1,617,559	2,306,978	4,948,595	64,184	472,154
87	Mon	08/02/10	14,856	43	60	60	60	60	54	0.0	2.5	2.5	5.7	2,675,326	1,625,406	2,314,151	4,965,611	64,405	473,151
	Tue	08/03/10	14,881	25	62	60	60	60	54	0.0				2,675,326	1,630,386	2,318,983	4,976,066	64,540	473,818
	Wed	08/04/10	14,904	23	62	60	60	60	54	0.0	1.9	1.2	6.1	2,675,326	1,634,564	2,322,888	4,984,658	64,652	474,484
	Thu	08/05/10	14,929	25	60	60	60	60	54	0.0	1.1	7.3	8.0	2,675,326	1,638,521	2,326,280	4,992,707	64,756	475,152
	Fri	08/06/10	14,951	22	62	62	62	62	54	0.0	3.5	1.7	6.2	2,675,326	1,644,194	2,331,751	5,003,952	64,902	475,518
	Sat	08/07/10	14,976	25	66	62	62	62	54	0.0	2.5	2.2	6.2	2,675,326	1,647,872	2,335,062	5,012,279	65,010	476,483
88	Mon	08/09/10	15,023	47	60	60	60	60	54	0.0	2.4	1.7	4.9	2,675,326	1,651,936	2,341,139	5,026,727	65,197	477,817
	Tue	08/10/10	15,047	24	62	62	62	64	54	0.0		3.5	4.3	2,675,326	1,651,936	2,344,917	5,035,077	65,306	478,484
	Wed	08/11/10	15,070	23	70	68	68	68	54	0.0	5.8	7.1	12.2	2,675,326	1,655,095	2,348,213	5,042,801	65,406	479,151
	Thu	08/12/10	15,094	24	78	76	76	76	54	0.0	8.6	3.7	11.4	2,675,326	1,659,536	2,351,976	5,051,745	65,522	479,817
	Fri	08/13/10	15,117	23	62	64	64	64	54	0.0	4.5	4.8	8.3	2,675,326	1,664,521	2,356,583	5,061,742	65,652	480,485
	Sat	08/14/10	15,141	24	74	64	64	64	54	0.0	2.0	4.8	11.1	2,675,326	1,669,829	2,360,901	5,072,309	65,789	481,155
89	Mon	08/16/10	15,188	47	66	60	60	60	54	0.0	2.7	2.9	6.0	2,675,326	1,678,053	2,368,684	5,089,546	66,012	482,488
	Tue	08/17/10	15,211	23	60	60	60	60	54	0.0	2.5	1.9		2,675,326	1,681,565	2,372,131	5,097,614	66,117	483,156
	Wed	08/18/10	15,235	24	66	60	60	60	54	0.0	2.2	2.6	4.9	2,675,326	1,686,344	2,376,342	5,107,525	66,245	483,801
	Thu	08/19/10	15,259	24	66	68	68	68	54	0.0	3.9	4.5	9.7	2,675,326	1,690,732	2,380,734	5,117,275	66,372	484,484
	Fri	08/20/10	15,283	24	60	60	60	60	54	0.0	3.2	1.4	5.6	2,675,326	1,693,935	2,383,848	5,123,894	66,458	485,147
	Sat	08/21/10	15,305	22	64	62	60	62	54	0.0	1.9			2,675,326	1,696,711	2,386,490	5,130,029	66,537	485,811
90	Mon	08/23/10	15,353	48	64	68	70	70	54	0.0	6.9	7.1	13.2	2,675,326	1,706,792	2,396,452	5,150,622	66,804	487,136
	Tue	08/24/10	15,379	26	60	60	60	60	54	0.0		1.2	1.6	2,675,326	1,711,860	2,401,433	5,159,925	66,925	488,469
	Wed	08/25/10	15,399	20	64	62	62	62	54	0.0	4.9	6.4	12.6	2,675,326	1,715,092	2,405,341	5,168,028	67,030	488,469
	Thu	08/26/10	15,423	24	60	60	60	60	54	0.0	3.2	6.0	6.9	2,675,326	1,719,967	2,410,653	5,178,735	67,169	489,135
	Fri	08/27/10	15,447	24	64	60	60	60	54	0.0	2.3	2.4	5.3	2,675,326	1,724,583	2,415,350	5,188,296	67,293	489,801
	Sat	08/28/10	15,472	25	68	68	68	68	54	0.0	5.0	4.9	9.3	2,675,326	1,728,302	2,419,185	5,196,354	67,398	490,464

Table A-1. Operational Data for Hot Springs Mobile Home Park in Willard, UT (Continued)

WK No.		Date	Hour Meter (hr) Record	Diff	Pressure IN	TA	TB	AP	TC	Flowrate IN	TA	TB	TC	Totalizer IN	TA	TB	TC	Total BVs (c)	BW Totalizer
			hr	hr	psi					gpm				gal				BVs	gal
91	Mon	08/30/10	15,518	46	62	60	60	60	54	0.0	3.6	3.7	7.6	2,675,326	1,735,636	2,426,383	5,211,545	67,595	491,791
	Tue	08/31/10	15,539	21	60	60	60	60	54	0.0			2.6	2,675,326	1,738,493	2,429,221	5,217,389	67,670	492,458
	Wed	09/01/10	15,568	29	60	60	60	62	54	0.0	2.3	2.3	4.9	2,675,326	1,743,200	2,434,228	5,227,084	67,796	493,794
	Thu	09/02/10	15,588	20	62	60	60	64	54	0.0	3.1	2.3	4.5	2,675,326	1,745,277	2,436,163	5,231,880	67,858	493,794
	Fri	09/03/10	15,611	23	64	60	60	60	54	0.0	4.3	4.1	4.2	2,675,326	1,748,358	2,439,426	5,238,286	67,941	494,461
	Sat	09/04/10	15,635	24	64	60	60	60	54	0.0	1.7		4.1	2,675,326	1,751,917	2,443,036	5,245,618	68,037	495,727
92	Mon	09/06/10	15,681	46	70	68	68	70	54	0.0	6.0	0.6	14.1	2,675,326	1,758,472	2,449,872	5,259,726	68,220	496,453
	Tue	09/07/10	15,707	26	62	60	60	62	54	0.0	10.9	10.0	5.1	2,675,326	1,762,797	2,454,511	5,268,552	68,334	497,460
93	Thu	09/16/10	15,917	210	60	60	60	60	54	0.0	2.6	3.1	6.2	2,675,326	1,800,677	2,492,226	5,348,708	69,374	503,119
	Fri	09/17/10	15,941	24	60	60	60	60	54	0.0	0.9	1.4	3.6	2,675,326	1,804,937	2,496,799	5,357,876	69,493	503,786
	Sat	09/18/10	15,967	26	64	64	64	64	54	0.0	11.6	11.3	8.5	2,675,326	1,810,799	2,503,069	5,370,062	69,651	504,789
94	Mon	09/20/10	16,013	46	66	62	62	62	54	0.0	3.9	2.9	5.8	2,675,326	1,820,920	2,513,341	5,391,588	69,930	505,779
	Tue	09/21/10	16,035	22	70	62	62	62	54	0.0	2.5	3.0	7.0	2,675,326	1,825,142	2,517,758	5,400,667	70,048	506,441
	Wed	09/22/10	16,059	24	74	72	72	72	54	0.0	6.5	6.4	13.5	2,675,326	1,829,326	2,522,016	5,409,378	70,161	507,105
	Thu	09/23/10	16,082	23	82	72	72	72	54	0.0	7.3	7.4	14.9	2,675,326	1,833,410	2,526,110	5,417,731	70,269	507,768
	Fri	09/24/10	16,106	24	62	58	58	60	54	0.0			1.7	2,675,326	1,837,411	2,530,143	5,426,100	70,377	508,431
	Sat	09/25/10	16,130	24	60	62	62	66	54	0.0	3.8	5.1	9.0	2,675,326	1,841,651	2,534,555	5,435,763	70,503	509,094
95	Mon	09/27/10	16,175	45	62	62	62	62	54	0.0	2.3	2.4	5.7	2,675,326	1,852,732	2,540,132	5,459,307	70,808	510,417
	Tue	09/28/10	16,202	27	72	70	70	70	54	0.0	5.1	5.1	8.7	2,675,326	1,859,198	2,552,877	5,473,145	70,988	511,076
	Wed	09/29/10	16,227	25	64	58	58	60	54	0.0	9.2	8.7	1.8	2,675,326	1,865,135	2,559,221	5,485,611	71,149	512,072
	Thu	09/30/10	16,251	24	60	60	60	60	54	0.0	3.6	2.0	4.9	2,675,326	1,869,872	2,563,901	5,495,253	71,274	513,056
	Fri	10/01/10	16,274	23	66	58	58	58	54	0.0	12.9	12.6	11.2	2,675,326	1,874,905	2,569,259	5,506,165	71,416	513,718
	Sat	10/02/10	16,297	23	60	62	62	62	54	0.0			1.0	2,675,326	1,880,065	2,574,454	5,516,548	71,551	514,377
96	Mon	10/04/10	16,340	43	66	66	66	66	54	0.0	4.4	4.8	9.4	2,675,326	1,886,122	2,580,576	5,530,060	71,726	515,038
	Tue	10/05/10	16,364	24	66	60	60	60	54	0.0			4.3	2,675,326	1,889,694	2,584,287	5,537,757	71,826	515,697
	Wed	10/06/10	16,388	24	60	60	60	60	54	0.0	3.9	3.3	6.9	2,675,326	1,892,505	2,587,406	5,544,338	71,911	516,358
	Thu	10/07/10	16,412	24	64	60	60	60	54	0.0	6.6	2.3	5.3	2,675,326	1,896,106	2,591,391	5,552,616	72,018	517,019
	Fri	10/08/10	16,440	28	60	58	58	58	54	0.0		1.8	7.9	2,675,326	1,899,851	2,595,462	5,560,461	72,120	518,846
	Sat	10/09/10	16,468	28	66	62	60	62	54	0.0	2.6	1.9		2,675,326	1,903,708	2,599,374	5,569,139	72,233	519,010
97	Mon	10/11/10	16,506	38	66	62	62	64	54	0.0	2.0	2.5	6.8	2,675,326	1,908,418	2,604,084	5,580,105	72,375	519,674
	Tue	10/12/10	16,534	28	60	60	60	60	54	0.0	2.4	0.8	3.7	2,675,326	1,912,492	2,608,203	5,588,320	72,481	521,002
	Wed	10/13/10	16,552	18	66	60	60	62	54	0.0	2.6	3.3	6.9	2,675,326	1,914,399	2,610,001	5,592,901	72,541	521,002
	Thu	10/14/10	16,576	24	64	70	70	70	54	0.0	5.7	5.4	14.9	2,675,326	1,918,055	2,613,476	5,600,449	72,639	521,667
	Fri	10/15/10	16,599	23	66	62	62	62	54	0.0	5.9		11.1	2,675,326	1,921,459	2,616,710	5,607,709	72,733	522,331
	Sat	10/16/10	16,622	23	70	66	66	66	54	0.0	4.0	4.2	9.0	2,675,326	1,925,158	2,620,219	5,615,502	72,834	522,995
98	Mon	10/18/10	16,670	48	66	66	66	66	54	0.0	1.5		5.3	2,675,326	1,932,197	2,626,768	5,629,084	73,010	524,319

(a) Meter required maintenance.
(b) Readings not taken initially.
(c) TA not having a dedicated flow totalizer.
(d) Data not recorded.
(e) Backwash flow meter/totalizer switched with TA flow meter/totalizer.
NA = not available

APPENDIX B

ANALYTICAL DATA

Table B-1. Analytical Data from Long-Term Sampling at Hot Springs Mobile Home Park in Willard, UT

Sampling Date		12/17/08					01/22/09					01/28/09					02/04/09[a]				
Sampling Location																					
Parameter	Unit	IN	TA	TB	AP	TC	IN	TA	TB	AP	TC	IN	TA	TB	AP	TC	IN	TA	TB	AP	TC
Bed Volume	10^3	-	-	-	-	0.7	-	-	-	-	5.5	-	-	-	-	6.2	-	-	-	-	7.0
Alkalinity (as $CaCO_3$)	mg/L	NA	NA	NA	NA	NA	139	144	139	142	139	139	137	137	139	139	143	141	141	138	143
Fluoride	mg/L	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-
Sulfate	mg/L	-	-	-	-	-	6.9	6.8	6.7	6.9	7.0	-	-	-	-	-	-	-	-	-	-
Nitrate (as N)	mg/L	-	-	-	-	-	0.2	0.2	0.2	0.2	0.2	-	-	-	-	-	-	-	-	-	-
Total P (as P)	µg/L	NA	NA	NA	NA	NA	117	57.6	58.2	58.0	<10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Silica (as SiO_2)	mg/L	NA	NA	NA	NA	NA	14.7	14.7	13.9	14.8	15.2	15.3	15.2	15.3	15.4	15.5	15.6	15.8	15.6	15.6	16.2
Turbidity	NTU	NA	NA	NA	NA	NA	1.7	<0.1	<0.1	<0.1	<0.1	3.5	0.1	<0.1	0.3	<0.1	3.6	0.7	0.6	0.9	0.5
pH	S.U.	NA	NA	NA	NA	NA	7.5	7.7	7.7	NA	7.7	NA	NA	NA	NA	NA	7.6	7.7	8.1	8.1	8.0
Temperature	°C	NA	NA	NA	NA	NA	15.1	15.7	15.9	16.1	16.0	NA	NA	NA	NA	NA	9.0	9.8	9.9	9.3	9.1
DO	mg/L	NA	NA	NA	NA	NA	5.0	4.2	NA	4.1	3.9	NA	NA	NA	NA	NA	5.8	4.8	4.5	4.1	5.3
ORP	mV	NA	NA	NA	NA	NA	189	181	171	167	169	NA	NA	NA	NA	NA	128	103	41	47	41
Total Hardness (as $CaCO_3$)	mg/L	-	-	-	-	-	117	124	121	122	121	-	-	-	-	-	-	-	-	-	-
Ca Hardness (as $CaCO_3$)	mg/L	-	-	-	-	-	95.8	103	99.6	100	99.5	-	-	-	-	-	-	-	-	-	-
Mg Hardness as $CaCO_3$)	mg/L	-	-	-	-		21.0	20.9	21.1	21.5	21.4	-	-	-	-	-	-	-	-	-	-
As (total)	µg/L	11.7	5.5	5.3	5.4	0.1	13.5	9.2	9.1	9.2	0.1	15.3	10.2	10.9	10.2	0.3	15.5	11.8	11.7	11.8	<0.1
As (soluble)	µg/L	-	-	-	-	-	11.9	9.0	9.2	9.0	0.2	-	-	-	-	-	-	-	-	-	-
As (particulate)	µg/L	-	-	-	-	-	1.6	0.2	<0.1	0.1	<0.1	-	-	-	-	-	-	-	-	-	-
As(III)	µg/L	-	-	-	-	-	5.8	0.3	0.3	0.3	0.3	-	-	-	-	-	-	-	-	-	-
As(V)	µg/L	-	-	-	-	-	6.1	8.7	9.0	8.7	<0.1	-	-	-	-	-	-	-	-	-	-
Fe (total)	µg/L	185	<25	<25	<25	<25	339	<25	<25	<25	<25	361	<25	<25	<25	<25	283	<25	<25	<25	<25
Fe (soluble)	µg/L	-	-	-	-	-	118	<25	<25	<25	<25	-	-	-	-	-	-	-	-	-	-
Mn (total)	µg/L	100	1.0	0.9	0.7	0.6	109	<0.1	<0.1	<0.1	<0.1	117	1.8	9.7	25.7	<0.1	109	45.1	0.9	47.2	0.1
Mn (soluble)	µg/L	-	-	-	-	-	110	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-
Ti (total)	µg/L	1.6	1.5	1.5	1.7	1.6	1.3	1.0	1.0	1.0	0.9	1.9	1.0	1.1	1.2	3.5	1.4	1.1	0.9	1.0	1.0
Ti (soluble)	µg/L	-	-	-	-	-	0.96	0.86	0.93	0.94	0.8	-	-	-	-	-	-	-	-	-	-

(a) Water quality parameters measured on 02/05/09.
NA = not available

Table B-1. Analytical Data from Long-Term Sampling at Hot Springs Mobile Home Park in Willard, UT (Continued)

Sampling Date		02/11/09					2/18/09[a]					02/25/09			03/04/09			3/10/09[b]			
Sampling Location																					
Parameter	Unit	IN	TA	TB	AP	TC	IN	TA	TB	AP	TC	IN	AP	TC	IN	AP	TC	IN	TA	TB	TC
Bed Volume	10^3	-	-	-	-	7.8	-	-	-	-	8.7	-	-	9.4	-	-	10.2	-	-	-	10.7
Alkalinity (as $CaCO_3$)	mg/L	149 -	149 -	147 -	149 -	147 -	147 -	147 -	144 -	144 -	142 -	138 140	144 142	140 140	137 -	139 -	137 -	147 -	145 -	145 -	145 -
Fluoride	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1
Sulfate	mg/L	7.0	6.4	6.5	6.7	6.6	-	-	-	-	-	-	-	-	-	-	-	6.6	6.5	6.4	6.5
Nitrate (as N)	mg/L	0.2	0.3	0.2	0.3	0.2	-	-	-	-	-	-	-	-	-	-	-	0.2	0.2	0.3	0.3
Total P (as P)	µg/L	98.7 -	65.3 -	61.8 -	62.4 -	<10 -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	132 -	83.3 -	79.9 -	<10 -
Silica (as SiO_2)	mg/L	15.7 -	15.4 -	15.4 -	15.4 -	15.8 -	14.6 -	14.6 -	14.4 -	15 -	14.4 -	15.1 15.0	15.0 15.0	15.4 14.9	15.2 -	15.2 -	15.7 -	15.0 -	14.6 -	15.0 -	15.0 -
Turbidity	NTU	1.7 -	<0.1 -	<0.1 -	<0.1 -	0.2 -	2.2 -	<0.1 -	<0.1 -	<0.1 -	0.1 -	10.0 9.5	0.2 0.2	0.3 0.3	2.1 -	<0.1 -	<0.1 -	2.4 -	0.2 -	<0.1 -	1.1 -
pH	S.U.	7.8	7.9	8.0	8.0	8.0	7.8	7.8	7.7	7.7	7.1	7.7	7.9	NA	7.5	7.7	7.7	7.7	NA	NA	7.7
Temperature	°C	15.6	16.5	16.5	16.7	16.5	15.2	15.6	15.6	15.8	15.6	14.0	14.2	NA	17.1	17.3	17.3	12.9	NA	NA	12.1
DO	mg/L	3.9	3.0	2.7	2.6	2.6	3.9	3.6	3.3	3.4	3.5	5.4	3.6	NA	3.6	3.3	3.3	3.7	NA	NA	2.5
ORP	mV	187	188	187	185	183	224	178	176	174	175	248	240	NA	222	217	204	205	NA	NA	189
Total Hardness (as $CaCO_3$)	mg/L	111	112	105	106	108	-	-	-	-	-	-	-	-	-	-	-	116	119	116	115
Ca Hardness (as $CaCO_3$)	mg/L	91.7	92.3	86.7	86.8	88.7	-	-	-	-	-	-	-	-	-	-	-	91.1	92.3	91.0	89.9
Mg Hardness (as $CaCO_3$)	mg/L	19.2	19.3	18.5	18.7	19.0	-	-	-	-	-	-	-	-	-	-	-	25.3	26.5	25.4	25.5
As (total)	µg/L	13.6 -	11.1 -	10.5 -	11.1 -	0.2 -	13.5 -	10.3 -	10.3 -	10.3 -	0.2 -	20.5 20.1	0.2 0.2	0.1 0.1	12.0 -	9.8 -	0.1 -	14.1 -	11.1 -	11.1 -	0.2 -
As (soluble)	µg/L	12.8	11.0	10.3	10.6	0.2	-	-	-	-	-	-	-	-	-	-	-	13.7	11.6	11.7	0.2
As (particulate)	µg/L	0.8	0.2	0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	0.5	<0.1	<0.1	<0.1
As(III)	µg/L	2.8	0.7	0.5	0.5	0.5	-	-	-	-	-	-	-	-	-	-	-	6.7	1.4	0.5	1.2
As(V)	µg/L	10.0	10.3	9.8	10.2	<0.1	-	-	-	-	-	-	-	-	-	-	-	7.0	10.2	11.2	<0.1
Fe (total)	µg/L	204 -	<25 -	<25 -	<25 -	<25 -	277 -	<25 -	<25 -	<25 -	<25 -	863 839	<25 <25	<25 <25	195 -	<25 -	<25 -	333 -	<25 -	<25 -	<25 -
Fe (soluble)	µg/L	115	<25	<25	<25	<25	-	-	-	-	-	-	-	-	-	-	-	157	<25	<25	<25
Mn (total)	µg/L	103 -	4.5 -	4.3 -	0.2 -	3.0 -	102 -	4.1 -	2.3 -	8.9 -	0.1 -	134 133	0.1 0.2	<0.1 <0.1	109 -	17.8 -	<0.1 -	120 -	0.8 -	0.3 -	1.9 -
Mn (soluble)	µg/L	104	<0.1	0.1	<0.1	0.2	-	-	-	-	-	-	-	-	-	-	-	115	0.1	0.2	<0.1
Ti (total)	µg/L	1.8 -	1.7 -	1.5 -	1.5 -	23.7 [c] -	1.7 -	1.2 -	1.3 -	1.3 -	2.8 -	3.3 3.3	2.9 2.7	1.6 1.7	2.2 -	1.8 -	1.7 -	2.1 -	1.8 -	1.6 -	268 -
Ti (soluble)	µg/L	1.0	0.9	0.9	0.9	0.8	-	-	-	-	-	-	-	-	-	-	-				

(a) Water quality parameters measured on 02/19/09.
(b) Water quality parameters measured on 03/12/09.
(c) Sample was reanalyzed and the result was similar.
NA = not available

Table B-1. Analytical Data from Long-Term Sampling at Hot Springs Mobile Home Park in Willard, UT (Continued)

Sampling Date		03/18/09			03/25/09			04/01/09			04/08/09			04/15/09			04/22/09			04/29/09		
Sampling Location																						
Parameter	Unit	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC
Bed Volume	10^3	-	-	11.6	-	-	12.3	-	-	13.1	-	-	13.4	-	-	14.1	-	-	14.8	-	-	15.6
Alkalinity (as $CaCO_3$)	mg/L	140 -	142 -	140 -	144 -	141 -	144 -	148 -	143 -	146 -	141 -	143 -	148 -	143 -	134 -	141 -	144 -	143 -	146 -	138 -	138 -	140 -
Fluoride	mg/L	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-
Sulfate	mg/L	-	-	-	-	-	-	-	-	-	6.6	6.8	6.7	-	-	-	-	-	-	-	-	-
Nitrate (as N)	mg/L	-	-	-	-	-	-	-	-	-	0.2	0.1	0.2	-	-	-	-	-	-	-	-	-
Total P (as P)	µg/L	- -	- -	- -	- -	- -	- -	- -	- -	- -	135 -	68.5 -	<10 -	- -	- -	- -	- -	- -	- -	- -	- -	- -
Silica (as SiO_2)	mg/L	14.7 -	14.6 -	15.1 -	14.0 -	13.9 -	14.1 -	14.1 -	13.9 -	14.4 -	14.7 -	15.0 -	15.2 -	16.2 -	16.4 -	16.7 -	15.5 -	15.7 -	15.9 -	17.5 -	17.5 -	18 -
Turbidity	NTU	0.9 -	0.1 -	5.1 -	1.9 -	0.8 -	1.3 -	4.8 -	0.6 -	2.4 -	2.4 -	1.1 -	0.6 -	3.4 -	0.8 -	1.9 -	1.9 -	0.2 -	0.5 -	3.6 -	<0.1 -	3.8 -
pH	S.U.	7.5	7.6	7.6	7.7	7.6	7.6	7.6	7.8	7.7	7.6	7.8	7.8	7.6	7.5	7.6	7.6	7.7	7.7	7.6	7.7	7.7
Temperature	°C	17.6	17.6	17.8	12.9	13.0	13.1	13.8	14.2	14.3	16.1	16.3	16.7	17.2	17.4	17.6	17.3	17.5	17.7	17.5	17.5	18.8
DO	mg/L	2.9	2.5	2.4	NA	NA	NA	NA	NA	NA	2.8	1.8	2.3	1.8	2.3	1.9	2.1	2.0	2.0	2.6	2.0	2.0
ORP	mV	205	208	212	203	197	195	207	211	195	218	221	203	223	190	186	211	191	189	213	193	185
Total Hardness (as $CaCO_3$)	mg/L	-	-	-	-	-	-	-	-	-	115	114	99.5	-	-	-	-	-	-	-	-	-
Ca Hardness (as $CaCO_3$)	mg/L	-	-	-	-	-	-	-	-	-	96.0	94.3	82.9	-	-	-	-	-	-	-	-	-
Mg Hardness (as $CaCO_3$)	mg/L	-	-	-	-	-	-	-	-	-	18.8	19.3	16.6	-	-	-	-	-	-	-	-	-
As (total)	µg/L	15.7 -	11.8 -	<0.1 -	15.1 -	11.6 -	0.2 -	14.7 -	11.9 -	0.2 -	15.2 -	11.2 -	0.5 -	15.1 -	10.9 -	0.5 -	14.6 -	13.0 -	0.9 -	12.7 -	10.2 -	0.4 -
As (soluble)	µg/L	-	-	-	-	-	-	-	-	-	15.1	9.6	0.7	-	-	-	-	-	-	-	-	-
As (particulate)	µg/L	-	-	-	-	-	-	-	-	-	<0.1	1.6	<0.1	-	-	-	-	-	-	-	-	-
As(III)	µg/L	-	-	-	-	-	-	-	-	-	7.4	0.3	0.3	-	-	-	-	-	-	-	-	-
As(V)	µg/L	-	-	-	-	-	-	-	-	-	7.7	9.3	0.4	-	-	-	-	-	-	-	-	-
Fe (total)	µg/L	358 -	<25 -	<25 -	254 -	<25 -	<25 -	<25 -	<25 -	<25 -	709 -	<25 -	<25 -	440 -	<25 -	<25 -	273 -	<25 -	<25 -	235 -	<25 -	<25 -
Fe (soluble)	µg/L	-	-	-	-	-	-	-	-	-	173	<25	<25	-	-	-	-	-	-	-	-	-
Mn (total)	µg/L	112 -	8.2 -	<0.1 -	122 -	3.2 -	0.1 -	110 -	32.2 -	9.9 -	127 -	1.0 -	0.9 -	123 -	2.0 -	<0.1 -	115 -	0.2 -	0.1 -	125 -	16.1 -	0.4 -
Mn (soluble)	µg/L	-	-	-	-	-	-	-	-	-	108	<0.1	0.2	-	-	-	-	-	-	-	-	-
Ti (total)	µg/L	1.8 -	1.7 -	4.9 -	1.3 -	1.2 -	2.4 -	2.5 -	1.8 -	2.5 -	2.2 -	1.5 -	3.2 -	2.2 -	1.5 -	1.6 -	2.1 -	1.8 -	2.2 -	1.8 -	1.6 -	1.8 -
Ti (soluble)	µg/L		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table B-1. Analytical Data from Long-Term Sampling at Hot Springs Mobile Home Park in Willard, UT (Continued)

Sampling Date		05/06/09			05/13/09			05/20/09			05/27/09			06/03/09			06/10/09			06/18/09[(a)]		
Sampling Location																						
Parameter	Unit	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC
Bed Volume	10^3	-	-	15.8	-	-	16.6	-	-	17.6	-	-	18.6	-	-	19.5	-	-	20.4	-	-	21.1
Alkalinity (as $CaCO_3$)	mg/L	138 -	140 -	138 -	142 -	142 -	140 -	143 -	143 -	145 -	144 -	144 -	144 -	152 -	147 -	149 -	148 148	148 146	148 146	152 -	150 -	152 -
Fluoride	mg/L	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	-	-	-	-	-	-
Sulfate	mg/L	6.6	6.4	6.6	-	-	-	-	-	-	-	-	-	3.2	6.5	6.5	-	-	-	-	-	-
Nitrate (as N)	mg/L	0.2	0.3	0.3	-	-	-	-	-	-	-	-	-	0.1	0.3	0.3	-	-	-	-	-	-
Total P (as P)	µg/L	117 -	74.9 -	34.5 -	- -	- -	- -	- -	- -	- -	- -	- -	- -	115 -	80.9 -	12.1 -	- -	- -	- -	- -	- -	- -
Silica (as SiO_2)	mg/L	16.4 -	17.6 -	15.8 -	17.0 -	14.3 -	16.8 -	15.9 -	16.2 -	16.2 -	15.7 -	16.1 -	15.4 -	15.9 -	16.0 -	16.5 -	15.8 15.7	16.0 15.8	15.9 15.8	15.5 -	15.7 -	15.9 -
Turbidity	NTU	2.5 -	0.3 -	1.0 -	2.9 -	4.8 -	4.5 -	2.0 -	0.4 -	0.4 -	5.2 -	0.8 -	5.0 -	1.3 -	0.4 -	0.7 -	1.4 2.5	1.6 0.5	2.5 1.6	2.3 -	4.0 -	4.1 -
pH	S.U.	7.6	7.6	7.6	7.6	7.7	7.8	7.6	7.8	7.7	7.6	7.6	7.6	7.6	7.7	7.7	7.5	7.7	7.7	7.6	7.7	7.8
Temperature	°C	17.9	18.7	19.1	15.0	15.6	15.9	19.5	19.5	19.6	19.4	19.3	19.4	20.1	20.2	20.4	17.8	17.8	17.8	17.8	17.9	17.8
DO	mg/L	2.0	1.3	1.1	2.6	2.0	1.8	1.8	1.6	1.7	2.1	1.5	1.6	1.8	1.6	1.5	1.7	1.5	1.7	1.7	1.6	1.7
ORP	mV	207	213	190	187	185	177	186	188	181	205	195	195	205	202	197	180	171	173	181	177	172
Total Hardness (as $CaCO_3$)	mg/L	107	109	110	-	-	-	-	-	-	-	-	-	116	111	111	-	-	-	-	-	-
Ca Hardness (as $CaCO_3$)	mg/L	86.9	88.4	89.6	-	-	-	-	-	-	-	-	-	96.6	92.9	93.3	-	-	-	-	-	-
Mg Hardness (as $CaCO_3$)	mg/L	20.4	20.7	20.5	-	-	-	-	-	-	-	-	-	18.9	17.8	17.9	-	-	-	-	-	-
As (total)	µg/L	13.1 -	9.8 -	2.5 -	12.3 -	0.5 -	0.5 -	14.1 -	12.0 -	0.5 -	12.5 -	10.6 -	0.5 -	12.8 -	10.4 -	0.5 -	11.5 11.6	10.3 10.1	0.5 0.4	13.3 -	12.1 -	0.6 -
As (soluble)	µg/L	12.0	10.1	2.5	-	-	-	-	-	-	-	-	-	12.8	10.8	0.5	-	-	-	-	-	-
As (particulate)	µg/L	1.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	<0.1	<0.1	<0.1	-	-	-	-	-	-
As(III)	µg/L	5.8	0.1	0.3	-	-	-	-	-	-	-	-	-	6.0	0.2	0.2	-	-	-	-	-	-
As(V)	µg/L	6.2	9.9	2.2	-	-	-	-	-	-	-	-	-	6.8	10.6	0.3	-	-	-	-	-	-
Fe (total)	µg/L	300 -	<25 -	<25 -	189 -	<25 -	<25 -	155 -	<25 -	<25 -	109 -	<25 -	<25 -	184 -	<25 -	<25 -	103 103	<25 <25	<25 <25	105 -	<25 -	<25 -
Fe (soluble)	µg/L	83	<25	<25	-	-	-	-	-	-	-	-	-	61	<25	<25	-	-	-	-	-	-
Mn (total)	µg/L	115 -	0.5 -	12.1 -	118 -	2.0 -	0.5 -	111 -	4.3 -	0.4 -	106 -	0.5 -	0.4 -	121 -	0.3 -	0.1 -	116 117	1.3 3.9	0.1 0.2	113 -	15.9 -	1.7 -
Mn (soluble)	µg/L	106	0.3	12.2	-	-	-	-	-	-	-	-	-	119	<0.1	0.1	-	-	-	-	-	-
Ti (total)	µg/L	1.9 -	1.6 -	1.5 -	1.6 -	5.1 -	1.6 -	1.6 -	1.3 -	1.1 -	1.2 -	0.9 -	2.6 -	1.5 -	1.3 -	1.1 -	1.7 1.8	1.6 1.6	1.4 1.4	1.5 -	1.7 -	12.6 -
Ti (soluble)	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(a) Water quality parameters measured on 06/17/09.

Table B-1. Analytical Data from Long-Term Sampling at Hot Springs Mobile Home Park in Willard, UT (Continued)

Sampling Date		06/24/09			06/29/09[a]			07/08/09			07/14/09			07/29/09			08/05/09[b]			08/12/09		
Sampling Location																						
Parameter	Unit	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC
Bed Volume	10^3	-	-	21.4	-	-	21.8	-	-	22.3	-	-	22.7	-	-	24.0	-	-	24.4	-	-	24.8
Alkalinity (as $CaCO_3$)	mg/L	142 -	146 -	140 -	135 -	149 -	146 -	146 -	148 -	150 -	142 -	144 -	140 -	138 -	140 -	138 -	139 -	141 -	139 -	142 -	142 -	144 -
Fluoride	mg/L	-	-	-	<0.1	<0.1	<0.1	-	-	-	-	-	-	<0.1	<0.1	<0.1	-	-	-	-	-	-
Sulfate	mg/L	-	-	-	6.2	6.2	6.2	-	-	-	-	-	-	6.3	6.3	6.6	-	-	-	-	-	-
Nitrate (as N)	mg/L	-	-	-	0.3	0.2	0.3	-	-	-	-	-	-	0.3	0.3	0.3	-	-	-	-	-	-
Total P (as P)	µg/L	- -	- -	- -	69.7 -	56.7 -	<10 -	- -	- -	- -	- -	- -	- -	167 -	99.9 -	28.4 -	- -	- -	- -	- -	- -	- -
Silica (as SiO_2)	mg/L	15.2 -	15.5 -	15.6 -	16.4 -	15.2 -	15.8 -	15.8 -	16.0 -	16.2 -	15.8 -	15.8 -	16.2 -	15.4 -	15.3 -	15.8 -	15.5 -	15.3 -	15.7 -	15.2 -	15.3 -	15.2 -
Turbidity	NTU	1.8 -	0.5 -	1.5 -	0.9 -	0.6 -	0.5 -	8.1 -	0.7 -	0.4 -	0.7 -	0.3 -	0.3 -	3.7 -	0.2 -	0.5 -	0.9 -	0.2 -	0.3 -	1.6 -	1.3 -	0.9 -
pH	S.U.	7.6	7.7	7.7	7.5	7.6	7.7	7.5	7.6	7.7	7.5	7.7	7.7	7.5	7.7	7.7	7.6	7.7	7.7	7.5	7.6	7.6
Temperature	°C	19.6	19.6	19.8	21.5	21.7	22.2	20.2	20.1	20.2	19.8	19.8	20.0	22.0	21.5	21.0	20.6	21.0	22.3	20.3	19.9	20.1
DO	mg/L	2.2	1.6	1.7	2.1	1.8	1.7	1.8	1.5	1.5	1.7	1.7	2.0	2.3	1.9	1.6	1.7	1.8	1.9	2.0	1.8	1.8
ORP	mV	112	181	169	181	178	178	183	180	185	167	157	151	166	156	152	190	182	177	199	206	207
Total Hardness (as $CaCO_3$)	mg/L	-	-	-	123	120	123	-	-	-	-	-	-	96.8	103	102	-	-	-	-	-	-
Ca Hardness (as $CaCO_3$)	mg/L	-	-	-	106	103	106	-	-	-	-	-	-	73.4	78.7	77.9	-	-	-	-	-	-
Mg Hardness (as $CaCO_3$)	mg/L	-	-	-	17.4	16.9	17.1	-	-	-	-	-	-	23.4	24.4	24.3	-	-	-	-	-	-
As (total)	µg/L	13.0 -	11.2 -	0.4 -	11.0 -	9.4 -	0.1 -	21.1 -	11.8 -	0.6 -	11.0 -	9.6 -	0.3 -	13.5 -	9.1 -	<0.1 -	10.8 -	8.8 -	<0.1 -	11.6 -	10.3 -	0.6 -
As (soluble)	µg/L	-	-	-	10.9	9.8	0.3	-	-	-	-	-	-	11.5	10.2	<0.1	-	-	-	-	-	-
As (particulate)	µg/L	-	-	-	0.1	<0.1	<0.1	-	-	-	-	-	-	2.1	<0.1	<0.1	-	-	-	-	-	-
As(III)	µg/L	-	-	-	4.1	<0.1	<0.1	-	-	-	-	-	-	5.1	<0.1	<0.1	-	-	-	-	-	-
As(V)	µg/L	-	-	-	6.9	9.3	0.2	-	-	-	-	-	-	6.4	10.1	<0.1	-	-	-	-	-	-
Fe (total)	µg/L	222 -	<25 -	<25 -	271 -	<25 -	62 -	871 -	<25 -	<25 -	65 -	<25 -	<25 -	361 -	<25 -	<25 -	107 -	<25 -	<25 -	78.4 -	<25 -	<25 -
Fe (soluble)	µg/L	-	-	-	210	<25	<25	-	-	-	-	-	-	73	<25	<25	-	-	-	-	-	-
Mn (total)	µg/L	103 -	1.5 -	0.4 -	94.4 -	<0.1 -	1.0 -	164 -	1.9 -	0.4 -	87.6 -	1.1 -	0.5 -	124 -	0.3 -	<0.1 -	109 -	0.2 -	<0.1 -	90.2 -	1.0 -	0.1 -
Mn (soluble)	µg/L	-	-	-	96.4	<0.1	<0.1	-	-	-	-	-	-	126	<0.1	<0.1	-	-	-	-	-	-
Ti (total)	µg/L	1.6 -	1.5 -	1.4 -	1.4 -	1.0 -	1.2 -	2.2 -	1.2 -	1.1 -	1.1 -	1.0 -	0.9 -	2.1 -	1.5 -	1.4 -	1.5 -	1.4 -	1.5 -	1.5 -	1.3 -	1.3 -
Ti (soluble)	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(a) Bed volume and WQP from 06/30/09.
(b) Water quality parameters from 08/06/09.

Table B-1. Analytical Data from Long-Term Sampling at Hot Springs Mobile Home Park in Willard, UT (Continued)

Sampling Date		08/18/09			08/26/09			09/02/09[a]			09/09/09[b]			09/16/09[c]			09/23/09			09/30/09		
Sampling Location																						
Parameter	Unit	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC
Bed Volume	10^3	-	-	25.2	-	-	25.6	-	-	26.4	-	-	27.1	-	-	27.7	-	-	28.4	-	-	29.0
Alkalinity (as $CaCO_3$)	mg/L	145 -	145 -	142 -	145 -	142 -	147 -	140 -	138 -	138 -	144 142	142 144	142 146	142 -	146 -	144 -	138 -	138 -	140 -	136 -	129 -	140 -
Fluoride	mg/L	-	-	-	0.1	0.2	0.2	-	-	-	-	-	-	-	-	-	<0.05	<0.05	<0.05	-	-	-
Sulfate	mg/L	-	-	-	6.5	6.2	6.3	-	-	-	-	-	-	-	-	-	5.9	5.8	5.9	-	-	-
Nitrate (as N)	mg/L	-	-	-	0.3	0.3	0.3	-	-	-	-	-	-	-	-	-	0.2	0.3	0.3	-	-	-
Total P (as P)	µg/L	- -	- -	- -	170 -	91.5 -	64.2 -	- -	- -	- -	- -	- -	- -	- -	- -	- -	150 -	71.9 -	28.3 -	- -	- -	- -
Silica (as SiO_2)	mg/L	15.1 -	14.8 -	15.1 -	15.8 -	15.7 -	16.0 -	15.5 -	15.6 -	15.6 -	15.8 15.7	15.8 15.5	15.9 15.9	15.4 -	14.0 -	15.2 -	14.3 -	14.1 -	14.3 -	15.5 -	15.5 -	15.8 -
Turbidity	NTU	5.2 -	0.4 -	0.8 -	9.5 -	7.4 -	2.2 -	2.1 -	1.4 -	0.1 -	1.1 1.5	0.7 0.8	0.2 0.4	2.6 -	0.2 -	2.5 -	4.3 -	0.2 -	1.3 -	3.3 -	0.8 -	1.1 -
pH	S.U.	7.5	7.7	7.8	NA	NA	NA	7.7	7.7	7.8	7.5	7.6	7.6	7.8	7.8	7.9	7.6	7.7	7.7	7.7	7.7	7.5
Temperature	°C	19.2	19.1	19.3	20.1	20.4	20.0	19.5	19.5	19.9	18.8	18.9	18.9	18.9	19.0	19.1	19.4	19.2	19.2	16.4	16.8	16.9
DO	mg/L	1.8	1.7	1.6	2.0	1.7	1.6	1.7	1.5	1.8	1.6	1.6	1.6	1.8	1.6	1.7	2.3	1.8	1.9	2.0	1.9	2.2
ORP	mV	190	185	182	203	202	199	191	193	190	182	170	171	180	174	167	185	182	181	187	181	231
Total Hardness (as $CaCO_3$)	mg/L	-	-	-	110	114	108	-	-	-	-	-	-	-	-	-	102	110	111	-	-	-
Ca Hardness (as $CaCO_3$)	mg/L	-	-	-	90.3	93.9	88.6	-	-	-	-	-	-	-	-	-	81.9	90.8	90.5	-	-	-
Mg Hardness (as $CaCO_3$)	mg/L	-	-	-	19.8	20.4	19.5	-	-	-	-	-	-	-	-	-	19.8	19.7	20.7	-	-	-
As (total)	µg/L	14.8 -	11.4 -	1.2 -	15.3 -	11.4 -	0.8 -	10.9 -	9.0 -	<0.1 -	10.6 10.3	8.8 8.7	<0.1 <0.1	13.7 -	11.1 -	0.9 -	16.7 -	11.5 -	1.0 -	13.4 -	11.0 -	1.0 -
As (soluble)	µg/L	-	-	-	12.5	10.8	0.7	-	-	-	-	-	-	-	-	-	7.9	11.2	1.0	-	-	-
As (particulate)	µg/L	-	-	-	2.8	0.6	0.1	-	-	-	-	-	-	-	-	-	8.8	0.3	<0.1	-	-	-
As(III)	µg/L	-	-	-	7.4	0.5	0.3	-	-	-	-	-	-	-	-	-	3.3	0.3	0.3	-	-	-
As(V)	µg/L	-	-	-	5.1	10.3	0.4	-	-	-	-	-	-	-	-	-	4.6	10.8	0.7	-	-	-
Fe (total)	µg/L	367 -	<25 -	<25 -	590 -	63 -	39 -	146 -	<25 -	<25 -	129 123	<25 <25	<25 <25	197 -	<25 -	<25 -	462 -	<25 -	<25 -	172 -	<25 -	<25 -
Fe (soluble)	µg/L	-	-	-	96	59	<25	-	-	-	-	-	-	-	-	-	56	<25	<25	-	-	-
Mn (total)	µg/L	111 -	3.2 -	2.2 -	140 105	0.4 <0.1	0.6 <0.1	110 -	0.6 -	<0.1 -	107 107	0.1 0.2	<0.1 <0.1	116 -	0.9 -	0.4 -	124 -	9.3 -	0.2 -	105 -	0.1 -	<0.1 -
Mn (soluble)	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	108	<0.1	<0.1	-	-	-
Ti (total)	µg/L	1.5 -	1.1 -	1.2 -	2.3 -	1.4 -	5.9 -	1.3 -	1.3 -	1.3 -	1.2 1.3	1.2 1.2	1.2 1.2	2.4 -	2.1 -	2.6 -	2.4 -	1.8 -	4.9 -	1.6 -	1.4 -	1.3 -
Ti (soluble)	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(a) Water quality parameters measured on 09/01/09.
(b) Water quality parameters measured on 09/08/09.
(c) Water quality parameters measured on 09/15/09.
NA = not available

Table B-1. Analytical Data from Long-Term Sampling at Hot Springs Mobile Home Park in Willard, UT (Continued)

Sampling Date		10/07/09			10/14/09			10/19/09 [(a)]			10/28/09			11/04/09			11/18/09			12/15/09		
Sampling Location																						
Parameter	Unit	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC
Bed Volume	10^3	-	-	29.6	-	-	30.3	-	-	30.7	-	-	31.6	-	-	32.4	-	-	33.8	-	-	36.7
Alkalinity (as $CaCO_3$)	mg/L	139 -	141 -	135 -	144 -	144 -	142 -	140 -	142 -	140 -	151 -	145 -	135 -	142 -	138 -	136 -	145 -	147 -	143 -	144 -	129 -	138 -
Fluoride	mg/L	-	-	-	-	-	-	<0.1	<0.1	<0.1	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Sulfate	mg/L	-	-	-	-	-	-	5.7	5.9	5.8	-	-	-	-	-	-	5.7	5.7	5.7	5.8	6.0	6.0
Nitrate (as N)	mg/L	-	-	-	-	-	-	0.3	0.4	0.3	-	-	-	-	-	-	0.3	0.3	0.3	0.3	0.3	0.3
Total P (as P)	µg/L	- -	- -	- -	- -	- -	- -	76.7 -	26 -	<10 -	- -	- -	- -	- -	- -	- -	56.6 -	18.7 -	<10 -	110 -	70.5 -	56.7 -
Silica (as SiO_2)	mg/L	13.3 -	14.7 -	14.8 -	13.8 -	13.9 -	14.0 -	14.4 -	14.4 -	14.3 -	15.8 -	16.0 -	15.9 -	14.9 -	14.9 -	15.0 -	15.9 -	15.7 -	15.9 -	15.9 -	15.6 -	15.6 -
Turbidity	NTU	1.4 -	0.6 -	0.5 -	1.2 -	0.3 -	0.7 -	3.0 -	0.3 -	0.2 -	3.3 -	4.2 -	3.8 -	1.3 -	0.7 -	0.6 -	1.9 -	0.9 -	9.9 -	2.6 -	0.4 -	0.5 -
pH	S.U.	7.7	7.6	7.8	7.5	7.6	7.8	7.6	7.8	7.8	7.9	7.8	7.8	7.5	7.6	7.7	7.4	7.9	7.9	7.5	7.6	7.7
Temperature	°C	16.7	16.9	19.0	17.9	18.0	18.0	17.8	17.8	17.9	15.8	16.1	15.9	17.0	17.1	16.8	13.3	13.6	13.5	14.2	14.4	14.4
DO	mg/L	1.8	1.9	1.7	1.6	1.6	2.8	1.9	1.8	1.7	2.2	1.8	1.9	2.0	2.1	2.2	2.7	2.2	2.5	2.2	2.0	2.1
ORP	mV	186	229	226	207	201	199	218	239	244	212	207	206	225	228	229	222	208	211	231	200	197
Total Hardness (as $CaCO_3$)	mg/L	-	-	-	-	-	-	129	126	130	-	-	-	-	-	-	120	122	121	123	120	116
Ca Hardness (as $CaCO_3$)	mg/L	-	-	-	-	-	-	112	110	113	-	-	-	-	-	-	100	102	101	103	101	97.8
Mg Hardness (as $CaCO_3$)	mg/L	-	-	-	-	-	-	16.7	16.2	16.4	-	-	-	-	-	-	20.0	19.9	19.9	20.1	18.7	18.6
As (total)	µg/L	13.3 -	11.9 -	0.8 -	10.8 -	9.8 -	<0.1 -	13.7 -	10.9 -	1.9 -	11.7 -	9.7 -	0.9 -	9.4 -	8.7 -	0.8 -	11.7 -	9.8 -	1.4 -	11.5 -	9.8 -	4.9 -
As (soluble)	µg/L	-	-	-	-	-	-	12.1	10.9	0.8	-	-	-	-	-	-	10.5	9.7	1.4	10.9	10.0	4.7
As (particulate)	µg/L	-	-	-	-	-	-	1.6	<0.1	1.1	-	-	-	-	-	-	1.2	<0.1	<0.1	0.6	<0.1	0.3
As(III)	µg/L	-	-	-	-	-	-	7.1	1.0	<0.1	-	-	-	-	-	-	4.7	0.3	0.3	6.0	0.2	2.1
As(V)	µg/L	-	-	-	-	-	-	5.0	9.8	0.7	-	-	-	-	-	-	5.8	9.4	1.1	4.9	9.8	2.6
Fe (total)	µg/L	119 -	<25 -	<25 -	120 -	<25 -	<25 -	351 -	<25 -	<25 -	238 -	<25 -	<25 -	141 -	<25 -	<25 -	219 -	<25 -	28 -	257 -	<25 -	<25 -
Fe (soluble)	µg/L	-	-	-	-	-	-	42	<25	<25	-	-	-	-	-	-	79	<25	<25	93	<25	<25
Mn (total)	µg/L	107 -	0.3 -	<0.1 -	96.4 -	0.2 -	<0.1 -	124 -	<0.1 -	<0.1 -	103 -	0.6 -	0.3 -	107 -	0.5 -	0.2 -	95.2 -	17.6 -	50.1 -	129 -	0.6 -	29.3 -
Mn (soluble)	µg/L	-	-	-	-	-	-	126	<0.1	<0.1	-	-	-	-	-	-	83.3	<0.1	0.1	125	0.2	38.8
Ti (total)	µg/L	1.4 -	1.4 -	1.9 -	1.8 -	1.7 -	1.6 -	2.5 -	2.0 -	2.8 -	2.2 -	2.0 -	2.9 -	2.0 -	1.9 -	1.9 -	1.7 -	1.4 -	444 -	2.2 -	2.8 -	3.8 -
Ti (soluble)	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(a) Water quality parameters from 10/17/09.

Table B-1. Analytical Data from Long-Term Sampling at Hot Springs Mobile Home Park in Willard, UT (Continued)

Sampling Date		01/12/10			02/10/10			02/23/10			03/09/10			03/22/10			04/06/10			04/19/10		
Sampling Location																						
Parameter	Unit	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC
Bed Volume	10^3	-	-	40.9	-	-	46.1	-	-	~48.0	-	-	49.2	-	-	50.4	-	-	51.9	-	-	53.5
Alkalinity (as $CaCO_3$)	mg/L	145 -	149 -	136 -	149 -	153 -	153 -	- -	- -	- -	148 -	151 -	153 -	- -	- -	- -	149 -	138 -	142 -	- -	- -	- -
Fluoride	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	-	-	-
Sulfate	mg/L	5.5	5.9	6.0	6.2	6.1	6.4	-	-	-	6.1	5.8	6.5	-	-	-	5.8	6.2	6.2	-	-	-
Nitrate (as N)	mg/L	0.2	0.2	0.3	0.2	0.3	0.3	-	-	-	0.3	0.3	0.4	-	-	-	0.2	0.3	0.3	-	-	-
Total P (as P)	µg/L	101 -	74.3 -	60.6 -	105 -	73.9 -	65.1 -	- -	- -	- -	101 -	54.1 -	44.0 -	- -	- -	- -	87.8 -	58.3 -	39.7 -	- -	- -	- -
Silica (as SiO_2)	mg/L	16.0 -	15.9 -	15.2 -	15.8 -	15.5 -	15.6 -	- -	- -	- -	14.4 -	14.3 -	14.4 -	- -	- -	- -	16.0 -	16.0 -	16.0 -	- -	- -	- -
Turbidity	NTU	2.0 -	0.5 -	0.4 -	2.1 -	0.3 -	0.4 -	- -	- -	- -	3.1 -	0.4 -	1.9 -	- -	- -	- -	1.8 -	0.1 -	0.2 -	- -	- -	- -
pH	S.U.	7.5	8.0	8.1	8.0	8.0	8.0	NA	NA	NA	7.6	7.7	7.8	NA	NA	NA	7.6	7.8	8.0	NA	NA	NA
Temperature	°C	12.5	13.6	14.1	15.0	15.3	15.8	NA	NA	NA	14.5	14.7	14.3	NA	NA	NA	13.1	13.1	13.4	NA	NA	NA
DO	mg/L	2.7	1.6	2.4	2.1	2.3	2.4	NA	NA	NA	2.8	2.2	2.3	NA	NA	NA	2.7	2.4	2.0	NA	NA	NA
ORP	mV	211	206.6	209	209	195	192	NA	NA	NA	171	174	167	NA	NA	NA	237	193	169	NA	NA	NA
Total Hardness (as $CaCO_3$)	mg/L	126	126	126	112	118	117	-	-	-	110	108	110	-	-	-	115	119	116	-	-	-
Ca Hardness (as $CaCO_3$)	mg/L	104	105	105	92.6	97.2	97.1	-	-	-	90.2	88.1	89.9	-	-	-	93.1	95.4	93.2	-	-	-
Mg Hardness (as $CaCO_3$)	mg/L	21.7	21.9	20.9	19.6	20.4	20.3	-	-	-	19.9	19.5	19.6	-	-	-	21.7	23.5	22.4	-	-	-
As (total)	µg/L	11.1 -	9.6 -	3.0 -	11.9 -	9.9 -	3.5 -	11.5 -	9.8 -	3.5 -	10.9 -	8.8 -	3.3 -	10.6 -	9.0 -	3.1 -	11.5 -	10.1 -	3.7 -	12.4 -	10.0 -	4.0 -
As (soluble)	µg/L	10.3	9.5	2.6	12.1	9.9	3.5	-	-	-	9.9	9.4	3.3	-	-	-	11.8	9.9	3.8	-	-	-
As (particulate)	µg/L	0.8	<0.1	0.3	<0.1	<0.1	<0.1	-	-	-	0.9	<0.1	<0.1	-	-	-	<0.1	0.2	<0.1	-	-	-
As(III)	µg/L	4.4	0.4	0.4	8.1	0.4	0.4	-	-	-	5.7	0.3	0.1	-	-	-	6.8	0.2	0.2	-	-	-
As(V)	µg/L	6.0	9.1	2.2	3.9	9.5	3.2	-	-	-	4.2	9.2	3.2	-	-	-	5.0	9.6	3.6	-	-	-
Fe (total)	µg/L	199 -	<25 -	<25 -	247 -	<25 -	<25 -	221 -	<25 -	<25 -	327 -	<25 -	<25 -	214 -	<25 -	<25 -	171 -	<25 -	<25 -	193 -	<25 -	<25 -
Fe (soluble)	µg/L	56	<25	<25	90	<25	<25	-	-	-	56	<25	<25	-	-	-	83	<25	<25	-	-	-
Mn (total)	µg/L	90.3 -	2.2 -	4.4 -	115 -	4.1 -	0.1 -	107 -	1.0 -	<0.1 -	128 -	0.2 -	0.2 -	113 -	1.4 -	<0.1 -	116 -	0.2 -	<0.1 -	116 -	0.2 -	<0.01 -
Mn (soluble)	µg/L	92.9	0.1	0.3	92.9	0.1	<0.1	-	-	-	101	<0.1	<0.1	-	-	-	123	0.1	<0.1	-	-	-
Ti (total)	µg/L	2.3 -	2.2 -	137 -	1.4 -	1.2 -	1.3 -	2.0 -	4.4 -	1.9 -	1.9 -	1.5 -	3.4 -	2.1 -	1.7 -	1.6 -	1.6 -	1.3 -	1.4 -	1.8 -	1.7 -	1.6 -
Ti (soluble)	µg/L	-	-	-	1.3	1.2	1.4	-	-	-	1.4	1.4	1.4	-	-	-	1.3	1.2	1.3	-	-	-

NA = not available

Table B-1. Analytical Data from Long-Term Sampling at Hot Springs Mobile Home Park in Willard, UT (Continued)

Sampling Date		05/05/10			05/17/10			06/07/10			06/14/10			06/30/10			07/12/10			07/27/10		
Sampling Location																						
Parameter	Unit	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC	IN	AP	TC
Bed Volume	10^3	-	-	55.5	-	-	56.7	-	-	58.8	-	-	59.4	-	-	60.8	-	-	62.1	-	-	63.7
Alkalinity (as $CaCO_3$)	mg/L	143 -	143 -	143 -	- -	- -	- -	152 -	143 -	161 -	- -	- -	- -	143 -	143 -	138 -	- -	- -	- -	146 -	137 -	151 -
Fluoride	mg/L	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1	-	-	-	<0.1	<0.1	<0.1
Sulfate	mg/L	6.3	6.3	6.3	-	-	-	6.2	6.3	6.2	-	-	-	6.3	6.4	7.1	-	-	-	5.8	6.8	6.2
Nitrate (as N)	mg/L	0.3	0.3	0.3	-	-	-	0.3	0.4	0.3	-	-	-	0.3	0.3	0.4	-	-	-	0.2	0.3	0.2
Total P (as P)	µg/L	96.0 -	72.3 -	58.6 -	- -	- -	- -	111 -	73.8 -	72.4 -	- -	- -	- -	99.7 -	70.0 -	77.6 -	- -	- -	- -	149 -	69.4 -	60.3 -
Silica (as SiO_2)	mg/L	15.4 -	15.5 -	15.3 -	- -	- -	- -	15.3 -	15.2 -	14.9 -	- -	- -	- -	15.1 -	15.1 -	15.4 -	- -	- -	- -	15.0 -	14.6 -	14.6 -
Turbidity	NTU	1.5 -	0.4 -	0.5 -	- -	- -	- -	3.3 -	1.2 -	0.6 -	- -	- -	- -	1.7 -	0.4 -	0.6 -	- -	- -	- -	5.0 -	0.5 -	0.8 -
pH	S.U.	7.6	7.9	8.0	NA	NA	NA	7.6	7.8	7.8	NA	NA	NA	7.5	7.7	7.9	NA	NA	NA	7.6	7.9	7.9
Temperature	°C	16.6	17.0	16.9	NA	NA	NA	20.2	20.2	20.3	NA	NA	NA	19.9	19.6	19.8	NA	NA	NA	20.2	19.5	20.1
DO	mg/L	2.3	1.7	2.3	NA	NA	NA	2.0	1.8	2.1	NA	NA	NA	1.8	1.7	1.7	NA	NA	NA	2.2	1.8	1.6
ORP	mV	209	179	187	NA	NA	NA	151	179	178	NA	NA	NA	241	235	228	NA	NA	NA	223	205	221
Total Hardness (as $CaCO_3$)	mg/L	104	108	106	-	-	-	127	116	124	-	-	-	114	112	111	-	-	-	108	113	111
Ca Hardness (as $CaCO_3$)	mg/L	84.8	87.8	85.7	-	-	-	107	96.8	103	-	-	-	94.6	92.9	92.3	-	-	-	89.0	93.6	92.2
Mg Hardness (as $CaCO_3$)	mg/L	19.3	20.1	20.3	-	-	-	20.7	19.4	21.0	-	-	-	19.3	19.0	18.4	-	-	-	19.1	19.2	18.6
As (total)	µg/L	11.6 -	11.4 -	4.1 -	10.7 -	9.4 -	4.0 -	13.9 -	11.7 -	5.4 -	12.9 -	10.9 -	5.1 -	12.3 -	10.0 -	4.9 -	17.1 -	12.1 -	5.6 -	14.6 -	9.9 -	4.9 -
As (soluble)	µg/L	10.8	11.0	3.9	-	-	-	12.7	11.4	5.3	-	-	-	12.1	10.8	4.8	-	-	-	12.9	10.7	5.2
As (particulate)	µg/L	0.8	0.4	0.1	-	-	-	1.1	0.3	0.1	-	-	-	0.2	<0.1	<0.1	-	-	-	1.6	<0.1	<0.1
As(III)	µg/L	5.3	0.1	0.1	-	-	-	7.8	0.4	0.3	-	-	-	6.7	0.2	0.2	-	-	-	8.3	0.2	0.2
As(V)	µg/L	5.5	10.9	3.8	-	-	-	4.9	11.0	5.0	-	-	-	5.4	10.6	4.6	-	-	-	4.7	10.5	5.0
Fe (total)	µg/L	156 -	<25 -	<25 -	179 -	<25 -	<25 -	234 -	<25 -	<25 -	224 -	<25 -	<25 -	197 -	<25 -	<25 -	828 -	<25 -	< 25.0 -	690 -	<25 -	<25 -
Fe (soluble)	µg/L	37	<25	<25	-	-	-	126	<25	<25	-	-	-	73.5	<25	<25	-	-	-	89	<25	<25
Mn (total)	µg/L	92.2 -	0.3 -	0.4 -	101 -	0.2 -	0.2 -	128 -	0.4 -	0.2 -	117 -	0.3 -	0.2 -	113 -	0.4 -	37.0 -	286 -	28.5 -	0.9 -	158 -	0.4 -	0.3 -
Mn (soluble)	µg/L	92.5	0.1	0.2	-	-	-	123	0.3	0.2	-	-	-	107	0.1	<0.1	-	-	-	130	0.1	<0.1
Ti (total)	µg/L	1.2 -	1.1 -	1.1 -	1.7 -	1.5 -	1.7 -	1.9 -	1.6 -	1.6 -	1.8 -	1.5 -	2.6 -	1.6 -	1.3 -	2.0 -	2.2 -	6.1 -	36.6 -	2.6 -	1.2 -	5.8 -
Ti (soluble)	µg/L	0.9	1.0	1.0	-	-	-	1.5	1.5	1.4	-	-	-	1.2	1.3	1.3	-	-	-	1.1	1.1	1.0

NA = not available

Table B-1. Analytical Data from Long-Term Sampling at Hot Springs Mobile Home Park in Willard, UT (Continued)

Sampling Date		08/16/10			09/07/10			09/14/10		
Sampling Location										
Parameter	Unit	IN	AP	TC	IN	AP	TC	IN	AP	TC
Bed Volume	10^3	-	-	66.0	-	-	68.3	-	-	~69.2
Alkalinity (as $CaCO_3$)	mg/L	- -	- -	- -	147 -	145 -	142 -	- -	- -	- -
Fluoride	mg/L	-	-	-	<0.1	<0.1	<0.1	-	-	-
Sulfate	mg/L	-	-	-	6.2	6.3	6.1	-	-	-
Nitrate (as N)	mg/L	-	-	-	0.3	0.3	0.3	-	-	-
Total P (as P)	µg/L	- -	- -	- -	108 -	81.4 -	69.8 -	- -	- -	- -
Silica (as SiO_2)	mg/L	- -	- -	- -	17.4 -	17.1 -	17.4 -	- -	- -	- -
Turbidity	NTU	- -	- -	- -	1.6 -	0.7 -	1.7 -	- -	- -	- -
pH	S.U.	NA	NA	NA	7.6	7.8	7.8	NA	NA	NA
Temperature	°C	NA	NA	NA	18.9	18.6	18.8	NA	NA	NA
DO	mg/L	NA	NA	NA	2.0	2.0	2.0	NA	NA	NA
ORP	mV	NA	NA	NA	209	196	193	NA	NA	NA
Total Hardness (as $CaCO_3$)	mg/L	-	-	-	110	103	98.0	-	-	-
Ca Hardness (as $CaCO_3$)	mg/L	-	-	-	83.0	78.0	73.8	-	-	-
Mg Hardness (as $CaCO_3$)	mg/L	-	-	-	26.6	25.4	24.2	-	-	-
As (total)	µg/L	11.4 -	9.9 -	5.3 -	12.5 -	10.9 -	7.0 -	14.3 -	11.9 -	6.2 -
As (soluble)	µg/L	-	-	-	11.9	11.2	7.2	-	-	-
As (particulate)	µg/L	-	-	-	0.5	<0.1	<0.1	-	-	-
As(III)	µg/L	-	-	-	6.9	<0.1	<0.1	-	-	-
As(V)	µg/L	-	-	-	5.0	11.1	7.1	-	-	-
Fe (total)	µg/L	190 -	<25 -	<25 -	205 -	<25 -	<25 -	188 -	<25 -	<25 -
Fe (soluble)	µg/L	-	-	-	80	<25	<25	-	-	-
Mn (total)	µg/L	103 -	0.3 -	<0.1 -	110 -	3.3 -	<0.1 -	120 -	0.6 -	0.4 -
Mn (soluble)	µg/L	-	-	-	105	<0.1	<0.1	-	-	-
Ti (total)	µg/L	1.3 -	1.2 -	2.0 -	1.6 -	1.9 -	2.2 -	1.7 -	1.4 -	1.3 -
Ti (soluble)	µg/L	-	-	-	1.4	1.4	1.4	-	-	-

NA = not available